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J. Mark Porter
Rancho Santa Ana Botanic Garden

Leigh A. Johnson
North Carolina State University

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PHYLOGENETIC RELATIONSHIPS OF POLEMONIACEAE: INFERENCES FROM MITOCHONDRIAL *NAD1B* INTRON SEQUENCES

J. MARK PORTER

Rancho Santa Ana Botanic Garden
1500 North College Ave
Claremont, CA 91711-3422
e-mail: j.mark.porter@cgu.edu

AND

LEIGH A. JOHNSON

Department of Botany
Box 7612
North Carolina State University
Raleigh, NC 27695-7612

ABSTRACT

The most recent assessments of phylogenetic relationships and diversification in the flowering plant family Polemoniaceae have relied on nuclear ribosomal and chloroplast DNA sequences. We employed the mitochondrial *nad1b* intron, located within the second transcription unit of the first subunit of NADH dehydrogenase, for phylogenetic inference. Maximum parsimony analysis of these data provided evidence that Polemoniaceae are more closely related to families Fouquieriaceae, Diapensiaceae, Styracaceae, and Primulaceae than to families of the Solananae, where it has been classified. Fouquieriaceae are inferred to be the sister group of Polemoniaceae; however, when indels are treated as additional characters and given twice the weight of a nucleotide substitution the sister group of Polemoniaceae is a clade that includes Fouquieriaceae, Diapensiaceae, and Primulaceae. Mitochondrial DNA sequences also provided support for an early diversification of Polemoniaceae involving three lineages: the *Acanthogilia* lineage, the *Cobaea-Cantua-Bonplandia* lineage, and a lineage including the remaining sampled genera of the family. These results are highly consistent with phylogenetic estimates based on chloroplast and nuclear gene sequences. However, because the exact branch order is not known with confidence for these three lineages, nor are the closest relatives to Polemoniaceae, assessments of homology in morphological characters remains tenuous. For example, both Fouquieriaceae and *Acanthogilia* possess primary leaves that become persistent spines. It was shown that, in spite of the morphological similarity, spiny primary leaves in Fouquieriaceae and Polemoniaceae are not homologous.

Key words: Polemoniaceae, mitochondrial *nad1b* intron sequences, phylogenetics, systematics.

INTRODUCTION

Polemoniaceae are a familiar component of the flora of the southwestern United States and northern Mexico where, as noted by Mason and Day (1948), local and seasonal climatic variation superimposed over geographic and edaphic variables provide these regions with a tremendous diversity of habitats and ecological niches. Polemoniaceae represent one of several families that have exploited this varied environment, as evidenced by high levels of regional endemism and the great diversity of genera and species existing in the floristic regions of the Southwest (Grant 1959). The combination of rich diversity in ecological preferences, morphology, and breeding systems, has contributed to the use of Polemoniaceae as a model for investigating patterns and processes of diversification in the flora of the southwestern United States. Recently, DNA sequence analyses of chloroplast and nuclear genes have been used to assess and clarify phylogenetic relationships for this family to provide a more reliable framework for ecological and evolutionary studies (Steele and Vilgalys 1994; Johnson et al. 1996, 1998 in press; Porter 1996). Novel insights into affinities among taxa and confidence limits on suggested relationships have been provided by these investigations. However, it is readily apparent that several important relationships pertaining to the early diversification of the family remain unclear. Principal among these are the branching pattern among the primary lineages within the family and the precise sister group affinities for the family as a whole—relationships that have been enigmatic historically as well.

For the last century Polemoniaceae have been considered a "natural group" (Grant 1959). However, Linnaeus (1737) placed portions of the family near *Convolvulus* and *Campanula* while other parts were placed near *Diapensia* and *Azalea.* It was not until the treatments of Persoon (1805) and deJussieu (1810) that most genera currently included in the family were classified together. Even so, there remained controversy regarding the inclusion of *Cobaea* in Polemoniaceae (Persoon 1805; deJussieu 1810; D. Don 1822, 1824; G. Don 1838). Following the work of Bentham (1845), most authors have included *Cobaea* within Polemoniaceae (but see Dahlgren 1980). In addition, several genera not currently included in Polemoniaceae, were periodically included, prior to the treatment of Bentham (1845). Particularly relevant to the present study are the genera *Diapensia,* included in Polemoniaceae by Ventenat (1794) and G. Don (1838), and *Fouquieria,* the first described species of which was included in the genus *Cantua* of Polemoniaceae (i.e., *Cantua fasciculata* Willd. ex Roem. & Schult.).

Like many flowering plant families, inferred relationships of Polemoniaceae with other families have varied from author to author, but a recurring pattern of suggested affinities is evident. Historically, Polemoniaceae have been most frequently aligned with Convolvulaceae (e.g., deJussieu 1789) or Solanaceae and Hydrophyllaceae (e.g., Bartling 1830). However, various authors have suggested relationships with many disparate families, including Primulaceae (Hallier 1905; Bessey 1915), Ericaceae (Brown 1938), and Fouquieriaceae (Engler and Gilg 1924; Flory 1937; Abrams 1951). Most recent classifications of flowering plants continue to ally Polemoniaceae with Convolvulaceae, Solanaceae, and Hydrophyllaceae (Grant 1959; Dahlgren 1980; Cronquist 1981; Thorne 1992; Takhtajan 1997).

Cladistic analyses of morphological data have thus far not provided a consistent, unambiguous picture of relationships between Polemoniaceae and other flowering plant families. Hufford's (1992) study of the relationships of Rosidae to other families found Polemoniaceae sharing most recent common ancestry with Pittosporaceae. When in a clade with Pittosporaceae, Polemoniaceae are depicted as the sister group to families of the Asteranae and Solananae (but not Theanae). Hufford noted, however, many traits shared by Polemoniaceae and some Theanae families (e.g., Ericaceae), including tricarpellate gynoecia, loculicidal capsules, lack of iridoid compounds, and the presence of ketose and isoketose oligosaccharides, without commenting on the inferred relationship with Pittosporaceae. Anderberg (1992) included Polemoniaceae in his examination of Ericales, where he found Polemoniaceae ambiguously associated with traditional Asteranae and Solananae families rather than showing Theanae affinities (but note that a potential synapomorphy with some Theanae families, carpel number, is ambiguously scored although the rare deviations from tricarpelly in Polemoniaceae are clearly derived). Neither analysis included measures of support; our own reanalyses of both data sets show that the addition of only 1 step to the most parsimonious tree length of both data sets is required to position Polemoniaceae variously among other taxa. Consequently, current quantitative phylogenetic approaches employing morphological evidence provide little additional insight into the placement of Polemoniaceae beyond showing that a close relationships with Convolvulaceae, Solanaceae, and Hydrophyllaceae are not unambiguously supported.

Phylogenetic relationships of Polemoniaceae suggested by molecular data have consistently been at odds with modern classifications (e.g., Cronquist 1981; Thorne 1992; Takhtajan 1997). Protein sequences of the nuclear encoded small subunit of ribulose-1,5-bisphosphate carboxylase/oxygenase (*rbcS*) provide evidence that supports the placement of Polemoniaceae away from Solanaceae and Hydrophyllaceae (Martin and Dowd 1991). The *rbcS* data support Polemoniaceae (not unambiguously a monophyletic group!) placed within a clade that includes Ericaceae, Epacridaceae, and Convolvulaceae. Chloroplast restriction site data (Downie and Palmer 1992) similarly suggest Polemoniaceae are not closely related to Solanaceae and Hydrophyllaceae; however, this analysis also separates Polemoniaceae from Convolvulaceae, the former being placed with Fouquieriaceae as the sister group of a clade that includes families of Asteranae and Solananae. Sequences of the chloroplast gene *rbcL* (large subunit of ribulose-1,5-bisphosphate carboxylase/oxygenase) likewise provide evidence for relationships between Polemoniaceae and Theanae families (including Fouquieriaceae), while also suggesting that Solanaceae, Hydrophyllaceae, and Convolvulaceae are only distantly related (Olmstead et al. 1992, 1993; Chase et al. 1993; Morton et al. 1997). Taxon sampling between the various *rbcL* analyses varies and, as a result, the inferred sister group relationship of Polemoniaceae also varies. Sequences of the chloroplast gene *matK* also provide evidence that Polemoniaceae are more closely related to Theanae (ericalean) families and Fouquieriaceae, than to Solanaceae (Johnson et al. 1996). More recently, analysis of nuclear encoded 18S ribosomal DNA sequences again supports the relationship between Polemoniaceae and Theanae families such as Fouquieriaceae, Diapensiaceae, Styracaceae, rather than Solanaceae, Hydrophyllaceae, and Convolvulaceae (Johnson et al. in press). All DNA and protein sequence evidence from both nuclear and chloroplast genes support the placement of Polemoniaceae away from Asteranae and Solananae; moreover, all but the *rbcS* protein sequence data, support Polemoniaceae as being distant from Convolvulaceae. Less clear from these studies is the sister group relationship of Polemoniaceae.

Even if molecular studies consistently suggest Theanae affinities for Polemoniaceae, inferred sister group relationships are not uniform. No doubt, one of the reasons for this, as noted above, is the great difference in taxon sampling. For example, Martin and Dowd (1991) included neither Fouquieriaceae nor Diapensiaceae, two families that, as will be shown, play a prominent role in this controversy. Figure 1 shows the inferred sister group relationships in some of the molecular analyses. The only analysis of a nuclear marker with moderate sampling is that of 18S DNA sequences (Johnson et al. 1998, in press), which provide support for Fouquieriaceae as the sister group to Polemoniaceae. Although chloroplast restriction site data reveal this same relationship, the lack of other Theanae families makes this support hollow. Further, sequence data from three genic regions of the chloroplast do not show consistent inferences of sister group relationships. Results from analyses of *rbcL* nearly always suggest that the sister group of Polemoniaceae is Diapensiaceae; however, the relationship between Fouquieriaceae and the Polemoniaceae-Diapensiaceae clade varies depending on taxon inclusion. Olmstead et al. (1992) found Polemoniaceae to be sister to Ericaceae, with Fouquieriaceae sharing most recent common ancestry with that clade; however, these were the only relevant Theanae families included in this analysis. Chase et al. (1993) performed two different analyses, Polemoniaceae being sister to Diapensiaceae in both; but in Search I, this clade is within a lineage that includes Ebenaceae, Primulaceae, and Myrsinaceae, whereas, in Search II the Polemoniaceae-Diapensiaceae clade part of a lineage that includes Fouquieriaceae and Balsaminaceae. Likewise, Olmstead et al. (1993) found Polemoniaceae to be sister to Diapensiaceae, but the relationships of this clade are ambiguous. In a more recent analysis of *rbcL*, Morton et al. (1997) found Polemoniaceae to be sister to a clade including Diapensiaceae and a portion of Styracaceae. This contrasts with results from analyses of *matK* that provide support for a sister group relationship involving Fouquieriaceae (Johnson et al. 1996). Preliminary analyses of *ndhF* (A. Prather, pers. comm.) support a still different sister group relationship: a clade, including Primulaceae, Myrsinaceae, and Balsaminaceae. Although both the nuclear 18S and chloroplast *matK* sequence data both support Fouquieriaceae as sister group, other chloroplast genes suggest contrary relationships. No clear consensus has emerged. It is apparent that additional evidence is still required.

This study provides an independent source of molecular evidence bearing on the phylogenetic relationships of Polemoniaceae. The mitochondrial genome has been little exploited in higher plant phylogenies (but see Hiesel et al. 1994; Pesole et al. 1996). This is in part due to the generalization that the plant mitochondrial genome is highly conserved in nucleotide sequence but highly plastic with respect to gene order (Palmer and Herbon 1988). Nevertheless, several variable intron regions within mitochondrial genes have been found that may provide suitable variation for phylogenetic inference. One such region is the *nad1b* intron, within the second transcription unit of the first subunit of NADH dehydrogenase, a trans-spliced gene (Bland et al. 1986; Stern et al. 1986; Bonen 1987; Schuster 1988; Chapdelaine and Bonen 1991; Wissinger et al. 1991). Mitochondrial *nad1b* intron sequences are here used to examine the phylogenetic relationships of Polemoniaceae and investigate which, if any, of the existing phylogenetic hypotheses (e.g., those based on nuclear and chloroplast genes) is corroborated. Inferences based on the several molecular data sets are then used to discuss the origins and early diversification of this family.

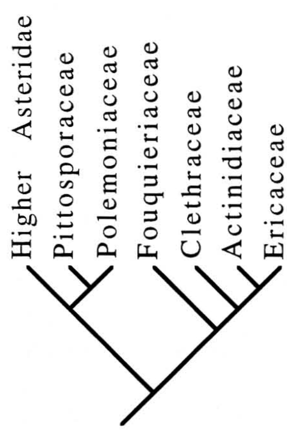
MATERIALS AND METHODS

Sampled Taxa

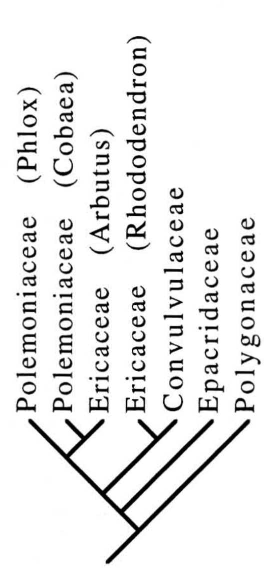
The sampling of 32 species represents 13 families of superorders Theanae, Solananae, Rosanae, Rutanae, Loasanae, Cornanae, and Asteranae (sensu Thorne 1992; Table 1). Included are 14 genera of Polemoniaceae from all major lineages identified by chloroplast *matK* (Johnson et al. 1996), *trnL-trnF* (Porter unpubl.), and nrDNA ITS (Baldwin et al. 1995; Porter 1996) sequence data. The outgroup has been selected as *Oenothera, Carpenteria,* and *Astragalus,* based on their inferred relationships to the ingroup in analyses of cpDNA *rbcL* (Chase et al. 1993) and 18S nrDNA (Soltis et al. 1997) sequence data. Sequences of the *nad1b* intron from *Oenothera* (Wissinger et al. 1991) and *Petunia* (Conklin et al. 1991) have been previously described and were obtained from GenBank. A sample of DNA from *Viburnum sieboldii* was kindly provided by M. Donoghue (Harvard University). For the remaining samples, total genomic DNA was extracted from fresh, frozen or dried leaf material ground to a powder in liquid nitrogen, using a modified 2X CTAB buffer protocol (Doyle and Doyle 1987) as described previously (Porter 1996).

PCR Amplification and Sequencing

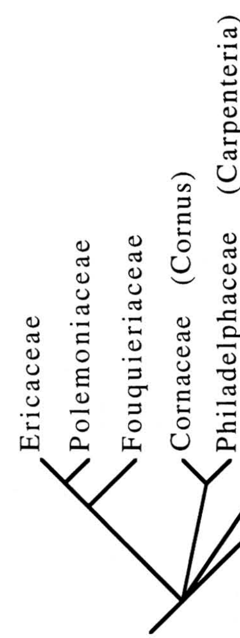
Sequencing was performed using an Applied Biosystems Model 373A Automated DNA Sequencing System (Perkin Elmer). Template DNAs were prepared by direct symmetric PCR of the entire *nad*1 b/c intron region using a 1:1 ratio of primers "*nad1*B" (5′-GCA



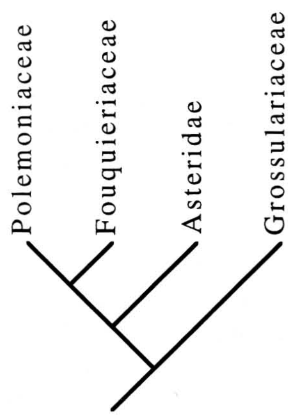
Hufford (1992)



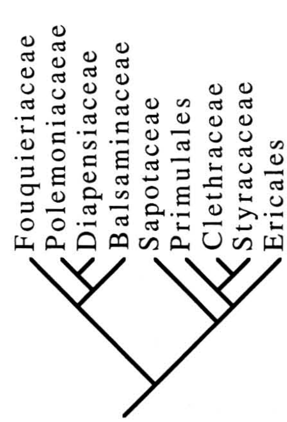
Martin and Dowd (1991)



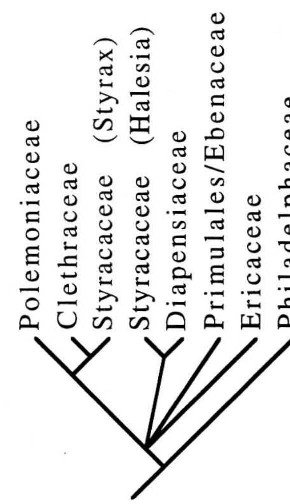
Olmstead et al. (1992)



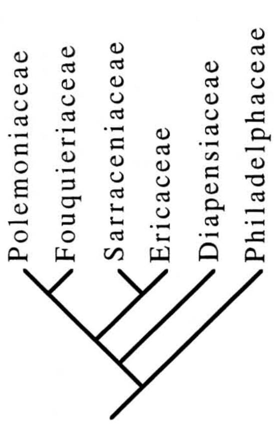
Downie and Palmer (1992)



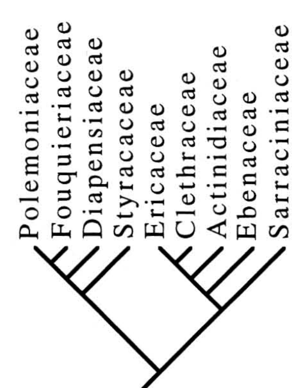
Chase et al. 1993



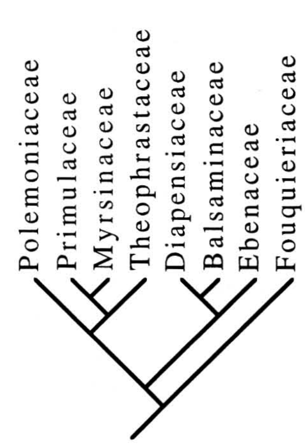
Morton et al. 1997



Johnson et al. (1996)



Johnson et al. (in press)



Prather pers. comm.

Table 1. Listing of sources of DNA sampled for comparative analysis of mitochondrial *nad1* intron sequences. Species name, flowering plant family, classification, and voucher are indicated. The rank of superorder, following the classification of Thorne (1992) has been used to denote classification of the samples.

Species name	Family	Superorder	Voucher
Oenothera berteriana Spach.	Onagraceae	Loasanae	N/A
Carpenteria californica Torrey	Philadelphaceae	Cornanae	*Porter 11577* (RSA)
Viburnum sieboldii Miq.	Adoxaceae	Cornanae	*M. Donoghue s.n.* (ARIZ)
Astragalus equisolensis Neese & Welsh	Fabaceae	Rutanae	*Porter 11578* (RSA)
Hymenoxys hoopesii (A. Gray)	Asteraceae	Asteranae	*Anderson 87-125* (RSA)
Hymenoxys richardsonii (Hook.) Cockerell	Asteraceae	Asteranae	*Anderson 88-105* (RSA)
Daipensia lapponica L.	Diapensiaceae	Rosanae	*Fay 325* (ARIZ)
Dodecatheon clevelandii Greene	Primulaceae	Theanae	*Porter 11579* (RSA)
Anagallis arvensis L.	Primulaceae	Theanae	*Porter 11580* (RSA)
Ornithostaphylos oppositifolia (C. Parry) Small	Ericaceae	Theanae	*Porter 11581* (RSA)
Styrax redivivus Torrey	Styracaceae	Theanae	*Porter 11582* (RSA)
Fouquieria splendens Engelm.	Fouquieriaceae	Theanae	*Porter 11583* (RSA)
Pholisma arenarium Hook.	Lennoaceae	Solananae	*Porter 11584* (RSA)
Petunia hybrida 3704b	Solanaceae	Solananae	N/A
Bonplandia geminifolia Cav.	Polemoniaceae	Solananae	*Patterson s.n.* (RSA)
Cantua quercifolia Juss.	Polemoniaceae	Solananae	*Patterson s.n.* (RSA)
Cobaea scandens Cav.	Polemoniaceae	Solananae	*Patterson s.n.* (RSA)
Acanthogilia gloriosa (Brandeg.) A. Day & R. Moran	Polemoniaceae	Solananae	*Porter & Heil 7987* (SJNM)
Polemonium formosissimum A. Gray	Polemoniaceae	Solananae	*Porter 7526* (SJNM)
Gilia cf. *scabra* Brandegee	Polemoniaceae	Solananae	*Porter & Heil 7991* (RSA; SJNM)
Gilia splendens H. Mason & A. Grant	Polemoniaceae	Solananae	*Porter 10142* (RSA)
Collomia grandiflora Lindley	Polemoniaceae	Solananae	*Ross & Boyd 8142* (RSA)
Allophyllum gilioides (Benth.) A. Grant & V. Grant	Polemoniaceae	Solananae	*Porter & Machen 8751* (RSA; SJNM)
Linanthus nuttallii (A. Gray) Milliken	Polemoniaceae	Solananae	*Porter & Machen 9004* (RSA; SJNM)
Leptodactylon pungens (Torr.) Rydb.	Polemoniaceae	Solananae	*Porter 8561* (SJNM)
Phlox gracilis (Dougl. ex Hook.) Greene	Polemoniaceae	Solananae	*Porter 10566* (RSA)
Loeselia glandulosa (Cav.) G. Don	Polemoniaceae	Solananae	*Porter & Campbell 9231* (AZ; RSA)
Ipomopsis aggregata (Pursh.) V. Grant	Polemoniaceae	Solananae	*Porter & Heil 8042* (SJNM)
Aliciella latifolia (S. Wats.) J. M. Porter	Polemoniaceae	Solananae	*O'Brien s.n.* (RSA)
Aliciella micromeria (A. Gray) J. M. Porter	Polemoniaceae	Solananae	*Porter & Machen 10834* (RSA)
Aliciella mcvickerae (M. E. Jone) J. M. Porter	Polemoniaceae	Solananae	*Porter & Machen 7184* (RSA; SJNM)
Aliciella subnuda (A. Gray) J. M. Porter	Polemoniaceae	Solananae	*Porter & Heil 7355* (SJNM)

TTA CGA TCT GCA GCT CA-3′) and "*nad1*C" (5′-GGA GCT CGA TTA GTT TCT GC-3′) as described by Demesure et al. (1995). The PCR products were electrophoresed on a 1.5% agarose gel in a 1X TBE (pH 8.3) buffer to confirm a single product and purified using either differential filtration in Millipore Ultra-Free-MC microfuge tubes (Millipore UFC-3 THK00), or by precipitation in 20% PEG/2.5M NaCl, followed by washing in 80% and 90% EtOH, and resuspension in 10–25 μl of sterile dH_2O. Direct cycle-sequencing of purified template DNAs followed manufacturer's specifications, using the PRISM™ Dye-Deoxy™ Terminator Kit (Perkin Elmer) and employed primers *nad1*B, *nad1*C, *nad1*–305F" (5′-CGA GCA AAC TCT GCA ACG TGA GAG CAA GGG ATC ACC-3′), "*nad1*–305R" (5′-GGT GAT CCC TTG CTC TCA CGT TCG AGA GTT TGC TCG-3′), "*nad1*–774F" (5′-CCG CCC GCC TTC ATT TCG TGG AAG T-3′), "*nad1*–1453F" (5′-ATG CTC TGA ACA CGA AAG TTT GCA G-3′), and "*nad1*–1453R" (5′-CTG CAA ACT TTC GTG TTC AGA GCA T-3′). The seven primers provide sequences for overlapping fragments that collectively cover the entire *nad1* intron region along both strands.

Sequence Editing and Alignment

Automated DNA sequencing chromatograms were proofed, edited and assembled into contigs, using Sequencher 3.0 (Gene Codes Corporation, Inc.). The *nad1b* intron region sequences were truncated to include only the group II intron. All exon regions were removed after identification of the 5′ and 3′ ends of the *nad1b* intron, based on comparisons with pub-

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Fig. 1. Phylogenetic relationships of Polemoniaceae as inferred from morphological (Hufford 1992), nuclear *rbcS* protein (Martin and Dowd 1991), nuclear ribosomal 18S (Johnson et al. in press), chloroplast *rbcL* (Olmstead et al. 1992; Downie and Palmer 1992; Chase et al. 1993; Morton et al. 1997), chloroplast *matK* (Johnson et al. 1996), chloroplast *ndhF* (Prather pers. com.) data. The phylogenies are "pruned trees," displaying only the relevant taxa.

lished sequences of *Oenothera* (Wissinger et al. 1991). Sequences were initially aligned using Clustal W (Higgins and Sharp 1987), followed by manual editing of the alignment, which considered canonical secondary structure estimates of the intron (Michel et al. 1989), as well as an appeal to parsimony (Baum et al. 1994).

Phylogenetic Analysis

Estimations of phylogenetic relationships were obtained using Fitch parsimony and maximum likelihood as implemented in PAUP* 4.0 (development version d54, D. Swofford, Smithsonian Institution). A variety of heuristic approaches was employed to help assure that all of the most parsimonious solutions were obtained. Initially, CLOSEST addition and TBR (tree bisection-reconnection) swapping was performed. This was followed by 100 replicates of RANDOM addition and TBR branch swapping. Finally, 500 replicates of RANDOM addition were carried out with no swapping, followed by TBR swapping on the resulting set of trees (Maddison 1991). This should insure that all minimal length trees are found, even if multiple "islands" of equally parsimonious trees exist. The data matrix was initially analyzed with equal weights at all nucleotide positions and with insertion/deletion (indel) positions treated as missing. Indels that could be unambiguously coded were treated as additional binary characters and weighted equal to, twice, and three times a nucleotide substitution in subsequent analyses.

Robustness and Sampling

An assessment of the relative support for clades provided by *nad*1b sequence data was performed using the decay index (Bremer 1988; Donoghue et al. 1992), character jackknifing (as implemented by the "parsimony jackknife," Farris et al. 1996), and the bootstrap (Felsenstein 1985). Decay values were calculated for each of the internal branches of the tree, using a method employing reverse constraint trees (Johnson and Soltis 1995). Character jackknifing was conducted using the PAUP 4.0* emulation of JAC (Farris et al. 1996) and was based on 100,000 pseudoreplicates. Results of this analysis are reported in terms of the estimated number of uncontradicted synapomorphies associated with each clade. If jackknife resampling of the original data set is set at 36.79% (= 1/e) of the total number of characters per pseudoreplicate, then the estimated number of uncontradicted synapomorphies can be determined using the equation:

$$E_{jP/G} = 1 - e^{-r} \qquad (1)$$

where $E_{jP/G}$ is the expected jackknife probability of a group, G; r is the number of uncontradicted synapomorphies; and e is approximately 2.718281828 (Farris et al. 1996). This is an approximate value because equation 1 is correct as the number of nucleotides approaches infinity; whereas, in our data the number of nucleotides is finite and less than 1600. Any clade with a probability value at or above 0.6321 can be considered well supported (at least 1 uncontradicted synapomorphy); however probability values equal to or greater than 0.8647, 0.9502, 0.9817, 0.9933, 0.9975, 0.9991, 0.9997, and 0.9999 correspond to 2, 3, 4, 5, 6, 7, 8, and 9 uncontradicted synapomorphies, respectively. Bootstrap values were calculated from 1000 replicate Fitch parsimony analyses, as implemented by PAUP 4.0*, using heuristic searches based on 10 random additions with TBR branch swapping.

RESULTS

Direct PCR amplification of the *nad1b* intron, as described above, proved successful in obtaining DNA sequences. However, PCR amplification of several samples (e.g., *Leptodactylon, Phlox,* and *Linanthus*) initially produced a very small fragment that corresponds to the flanking exon pieces with the intron precisely excised. Because the exon pieces were highly divergent relative to all remaining sampled taxa, we reamplified these species using a combination of internal and flanking primers. Subsequent amplifications successfully generated intron sequences. Our explanation for the initial inability to directly amplify the intron is that the first amplifications produced fragments of a processed pseudogene copy of *nadh,* likely residing in the nucleus. The pseudogene copy was preferentially amplified because of its shorter length. Likewise, we believe that other sampled taxa did not posses the short DNA fragment due to: (a) loss of the flanking priming sites in the pseudogene copy; (b) the *Leptodactylon–Phlox–Linanthus* pseudogene being orthologous to and more recent than pseudogene copies of other sampled taxa; or, (c) a combination of these two explanations.

Mitochondrial nad1b *Intron Sequence Variation*

Within the study group, the overall length of the *nad1b* intron, classified as a group IIA intron (Michel et al. 1989), shows a high degree of variation. Representatives of Polemoniaceae range from 1063 (*Gilia splendens*) to 1595 (*Collomia grandiflora*) nucleotide bases, and average approximately 1461 bases. *Collomia grandiflora* possesses the largest published *nad1b* intron. The length variants are primarily the result of insertions and deletions (indels) in domains II and IV. Some of these may be very large indels (over 590 bp). The intron of remaining members of the ingroup range from 784 (*Hymenoxys hoopesii* and *H. richardsonii*) to 1484 bp (*Styrax redivivus*). The average length of the intron for the entire ingroup, including Polemoniaceae, is approximately 1365 bp. The introns from the three members of the outgroup range from 1174 (*Astragalus equisolensis*) to 1464 bp (*Oenothera biternata*). In Polemoniaceae, overall percent G+C content of *nad1b,* is relatively constant, ranging from 53.8% in *Bonplandia geminiflora* to 56.2% in *Gilia splendens,* with an average G+C content in the family of 54.8%. However, on a domain by domain basis G+C content varies greatly (Friar and Porter in press). For example in Polemoniaceae, domain VI uniformly has a G+C content of 100.0%. The G+C content of the ingroup, exclusive of Polemoniaceae, similarly shows low variation, ranging from 53.3% in *Diapensia lapponica* to 55.5% in *Viburnum sieboldii,* the mean being 54.7%. G+C contents of the three members of the outgroup range from 54.3% (in *A. equisolensis*) to 55.6% (*O. biternata*), with mean of approximately 55.2%.

Alignment

Secondary structural constraints as well as self splicing function result in highly conserved regions in the *nad1b* intron that are flanked by more variable regions. The conserved regions are easily and unambiguously aligned; however, within the variable regions a few alignment-ambiguous regions are found (Appendix 1). In several cases the ambiguity is attributable to the presence of a tandem repeat, where it is not clear which repeat is the paralogue and which is the orthologue. These alignment-ambiguous regions generally do not alter the coding of informative nucleotide positions, although the assessment of homology of indels may be in question. As a result, these indel regions were not coded as additional binary characters.

The aligned, combined *nad1b* intron sequences required approximately 69 gaps in the data matrix. The most frequently occurring indel size (approximately 30% of all indels) is a single nucleotide in length. Six indels were 100 nucleotides in length or greater. In those cases where the indels are larger than 100 nucleotides in length, there is some concern that the indels may contribute to a lack of resolution, or error in the phylogenetic estimate, as some of these indels do overlap. The combined data matrix possesses 1756 characters, of which 1253 (71.35%) are invariant and 182 (10.36%) are potentially informative. The pairwise levels of divergence range from 0.3% (between *Aliciella mcvickerae* and *Aliciella latifolia*) to 10.3% (between *Pholisma arenaria* and *Bonplandia geminiflora*).

Phylogenetic Analysis

All parsimony analyses of the full, equal-weighted data set, with indels treated as missing (analysis I), resulted in recovery of the same 24 minimum-length trees. For the data set including only potentially informative sites, the most parsimonious trees were of 346 steps (tree length including all sites is 697), with a consistency index (C.I.) of 0.679, and retention index (R.I.) of 0.829. The strict consensus tree (Fig. 2) shows that the primary areas of disagreement in the set of minimal length trees involves: (a) relationships involving *Styrax, Diapensia,* the Primulaceae clade, and the Fouquieriaceae-Polemoniaceae clade; and, (b) relationships within Polemoniaceae involving *Gilia splendens, Allophyllum, Collomia, Linanthus,* and *Leptodactylon.* All of the minimal length trees agree in the inference of Fouquieriaceae as the sister group to Polemoniaceae and of Polemoniaceae as more closely related to Theanae representatives than to Solanaceae or Lennoaceae (Solananae representatives).

Inclusion of indel characters has an influence on phylogenetic inferences of the sister group and relationships within Polemoniaceae based on *nad1b* sequence data. Figure 3 shows the strict consensus of nine trees resulting from an analysis treating each reliably coded indel as an additional binary coded character, equal in weight to a nucleotide substitution (analysis II). The nine trees include six of the 24 trees from analysis I, as well as a second island of three trees. The island of three trees differs from the remaining trees in that Fouquieriaceae are the sister group to *Diapensia* and the two representatives of Primulaceae, rather than being the sister group of Polemoniaceae. When indels are given twice the weight of a nucleotide substitution (analysis III) only three minimal length trees are recovered. The strict consensus of the three trees from analysis III (Fig. 4) reveals that all trees place Fouquieriaceae as the sister group to *Diapensia* and the two representatives of Primulaceae, rather than Polemoniaceae. When additional weight is given to indels (3 times a nucleotide substitution), the three resulting trees are identical to those of analysis III.

Tree Support

A consistent pattern of character support is provided by bootstrap, decay, and jackknifing procedures. All clades that have greater than 70% bootstrap replication support (Hillis and Bull 1993, but also Felsenstein and Kashino 1993) also possess at least one uncontradicted synapomorphy and a decay value of at least two. Unfortunately, only 12 nodes display this support. The clade including representatives of Asteranae, Solananae (exclusive of Polemoniaceae), and *Viburnum* is well supported as monophyletic. The monophyly of Polemoniaceae is very strongly supported. With 27 changes along the branch leading to Polemoniaceae (ACCTRAN reconstruction from Analysis I), this is one of the two longest internal branches in the set of trees. Ancestry of Polemoniaceae is not inferred to be

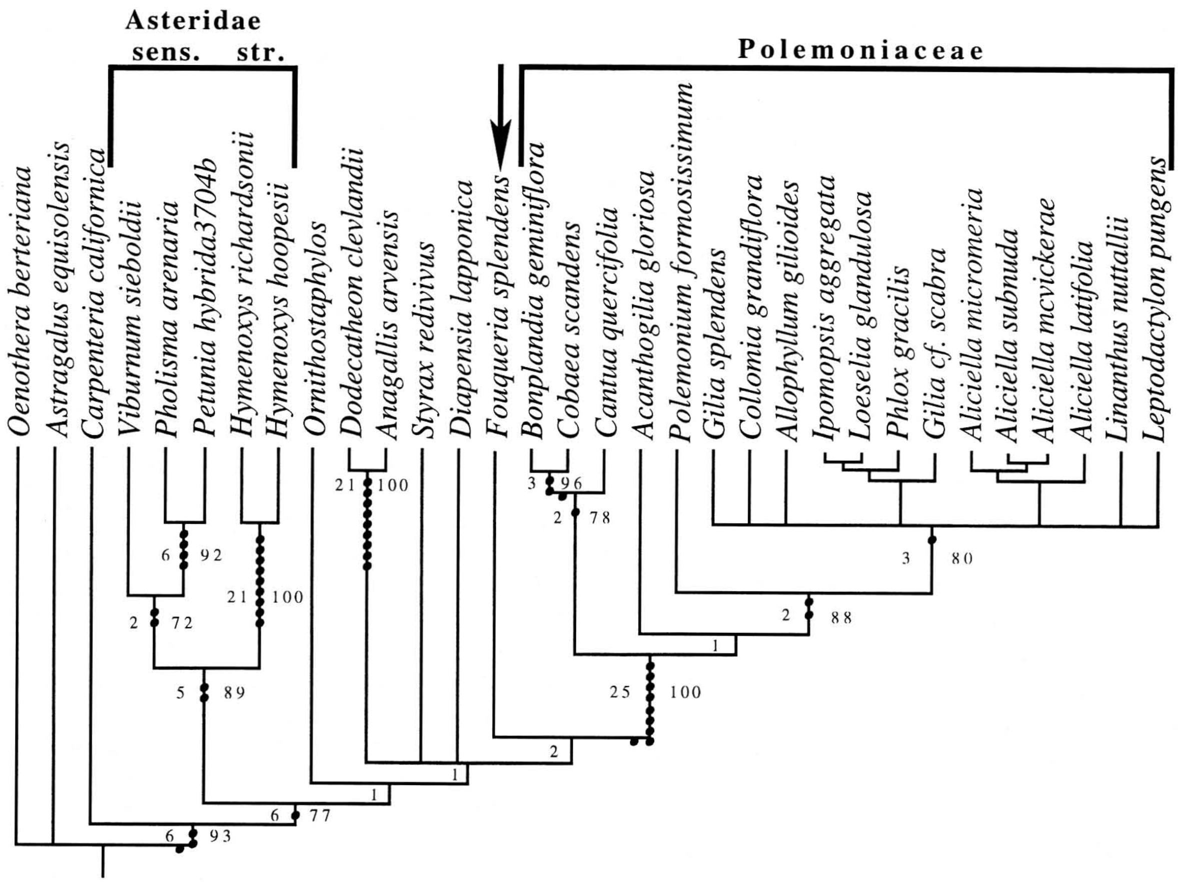

Fig. 2. Strict consensus of 24 most parsimonious trees, of tree length 697 (C.I. = 0.679, R.I. = 0.829), resulting from a maximum parsimony analysis of *nad1b* intron sequences, treating all indels as missing data (Analysis I). Bootstrap replication values above 70% are displayed to the right of the branch below the assessed node; decay index values are shown to the left. The number of dots along branches subtending a node denotes the number of uncontradicted synapomorphies supporting that node, based on parsimony jackknife. The arrow identifies the inferred sister group to Polemoniaceae.

within or near Solananae. Rather, Polemoniaceae are well supported as sharing ancestry with representatives of Theanae and *Diapensia*; but the precise sister group relationships for Polemoniaceae are not strongly supported.

DISCUSSION

Phylogenetic Utility of nad1b *Intron Sequences*

This analysis of comparative nucleotide sequence data of the mitochondrial *nad1b* intron demonstrates the general utility of this region for phylogenetic inference in angiosperms. Although few quantitative comparisons between this and other genic regions have been made (Friar and Porter 1998 in press; Johnson and Porter unpublished), several general observations can be made. Within Polemoniaceae the *nad1* intron is evolving at approximately one eighth the rate of nrDNA ITS sequences, and one third the rate of chloroplast *trnL* intron sequences (Friar and Porter 1998 in press). This places the *nad1b* intron in a similar rate class to chloroplast *rbcL* and nuclear 18S rDNA sequences. Comparisons with the *rbcL* analysis of Ebenales (Morton et al. 1997) reveals that a similar frequency of strongly supported clades (based on parsimony jackknifing) is observed in the *nad1b* intron analysis. Similarly, the 18S analysis by Johnson et al. (in press) possesses fewer well supported clades, as assessed using the bootstrap and decay analyses, than does this *nad*1b intron analysis. These 18S and rbcL analyses are reasonable studies for comparison as the taxonomic scales are similar to the study here presented, even though taxonomic sampling is not identical.

Phylogenetic Inferences

Monophyly and classification of Polemoniaceae.—Mitochondrial *nad1b* intron sequences provide further evidence that Polemoniaceae (including the genus *Cobaea*) is both monophyletic and only distantly related to Solanalean families. The best supported node in the tree derived from the *nad1b* analysis is that uniting Polemoniaceae (Fig. 2). In Analysis I, this branch possesses 26 character-change events (six additional characters may also change on this branch), has a decay

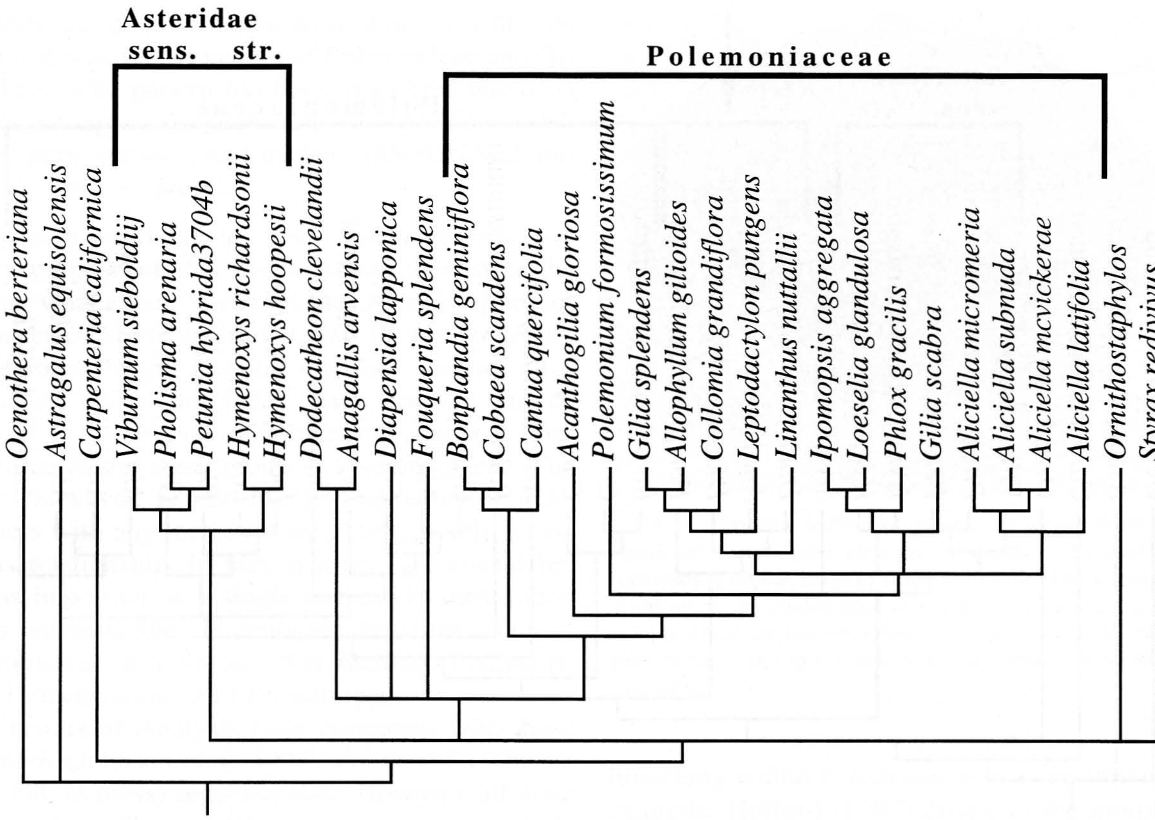

Fig. 3. Strict consensus of 9 most parsimonious trees, resulting from a maximum parsimony analysis of *nad1b* intron sequences, treating each unambiguously codable indel as an additional binary character of equal weight to one nucleotide substitution (Analysis II).

index value of 25, and parsimony jackknifing suggests that there are at least nine uncontradicted synapomorphies. This level of support is found regardless of the treatment of indel characters, one of which also supports the monophyly of Polemoniaceae. These mitochondrial DNA sequences agree with nuclear 18S (Johnson et al. 1998 in press), chloroplast *matK* (Johnson et al. 1996) and *ndhF* (Prather pers. comm.) sequences that place *Cobaea* within Polemoniaceae; consequently, molecular data from all three plant genomes do not support Dahlgren's (1980) treatment of *Cobaea* as a separate family, Cobaeaceae. In addition, the "long branch" leading to Polemoniaceae has also been observed in analyses of 18S (Johnson et al. 1998, in press), chloroplast *matK* (Johnson et al. 1996) and *ndhF* (Prather pers. comm.) sequences. This "long branch" may indicate that the Polemoniaceae lineage has experienced high extinction of early-diverging taxa, resulting in a single surviving lineage that has undergone a relatively recent diversification. Alternatively, this lineage may have existed for a very long time without diversification, followed by a relatively recent and rapid radiation.

The parsimony analysis of *nad1b* intron sequences provides support for close relationships between Polemoniaceae and Fouquieriaceae, Diapensiaceae, Styracaceae, and Primulaceae, rather than Solanaceae (Solananae). The placement of Solanaceae within Asteridae sensu stricto (s.s.) is strongly supported (Fig. 2), and Polemoniaceae are decidedly outside of Asteridae s.s. This is in agreement with previous phylogenetic analyses of nuclear (Martin and Dowd 1991; Johnson et al. 1998 in press) and chloroplast (Olmstead et al. 1992; Johnson et al. 1996; Morton et al. 1997) genes, and chloroplast restriction site data (Downie and Palmer 1992). Consequently, *nad1b* intron sequences again agree with sequences from the other plant genomes in refuting the classification of Polemoniaceae within or near Solanales (e.g., Dahlgren 1980; Cronquist 1981; Thorne 1992; Takhtajan 1997).

Diversification in Polemoniaceae.—The reliability of phylogenetic estimation within Polemoniaceae is relatively high at the more basal nodes. This, however, is not the case for all inferred relationships within Polemoniaceae. For example relationships among *Gilia, Collomia, Allophyllum, Aliciella, Linanthus, Leptodactylon,* and *Phlox* are ambiguous, and, furthermore, vary with different weightings of indels. In none of the *nad1b* analyses did *Linanthus, Leptodactylon,* and *Phlox* form a monophyletic group, a result strongly contradicted by previous molecular phylogenetic analyses of Polemoniaceae (e.g., Johnson et al. 1996; Porter 1996). However, the *nad* intron from *Linanthus,*

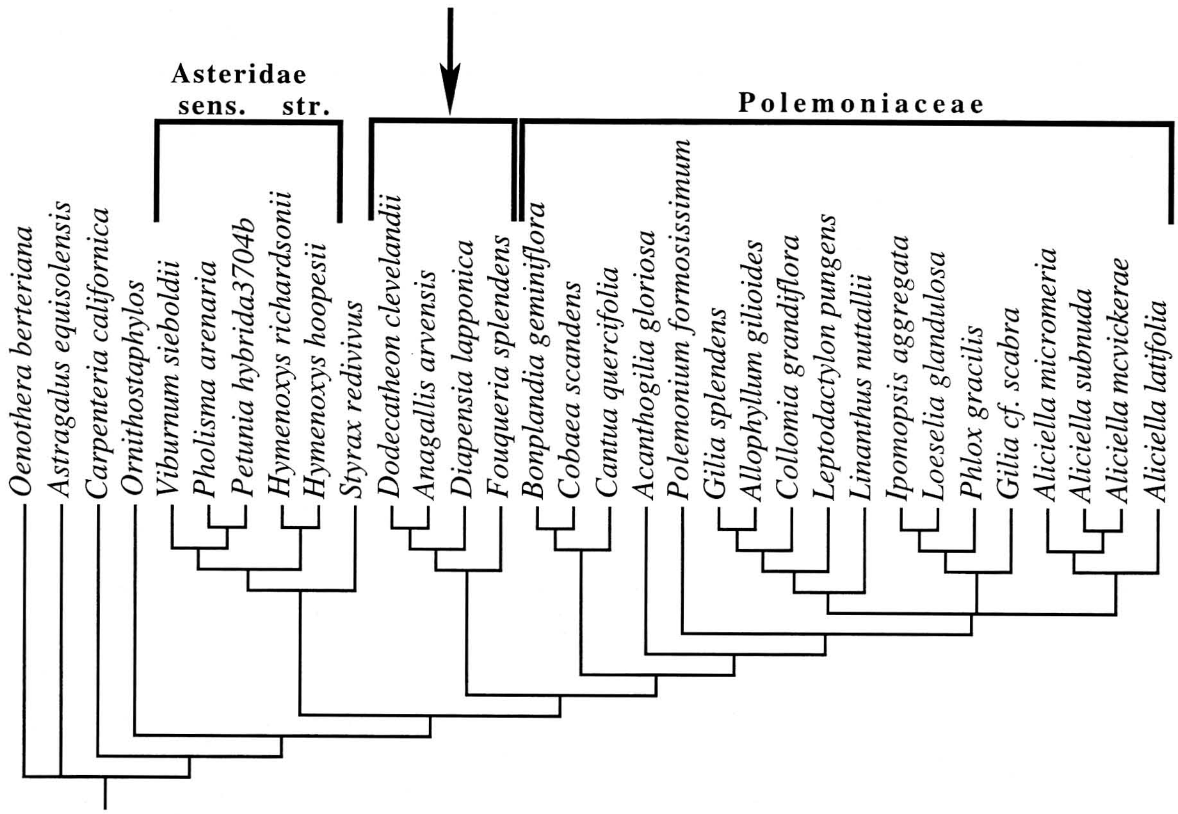

Fig. 4. Strict consensus of 3 most parsimonious trees, resulting from a maximum parsimony analysis of *nad1b* intron sequences, treating each unambiguously codable indel as an additional binary character and twice the weight of a nucleotide substitution (Analysis III). The arrow identifies the inferred sister group to Polemoniaceae.

Leptodactylon, and *Phlox* could not be amplified intact; rather, it was amplified in two pieces. As a result, sequence was not obtained for a small region in the middle of the intron. It is not clear if the missing data, in combination with several large indels, contribute to the anomalous placement of *Linanthus, Leptodactylon,* and *Phlox,* or if this reflects an unusual pattern of lineage sorting of the mitochondrial genome. Such evident complications were not observed in other taxa.

The most recent classification of Polemoniaceae (Grant 1959) recognizes five tribes, three of which are informally referred to as "tropical" while the remaining two are called "temperate." The so called tropical tribes include Cobaeeae (*Cobaea*), Cantueae (*Cantua* and *Huthia*) and Bonplandieae (*Loeselia* and *Bonplandia*), while the "temperate" tribes are Polemonieae (*Polemonium, Allophyllum, Collomia, Phlox,* and *Gymnosteris*) and Gilieae (*Gilia, Ipomopsis, Eriastrum, Langloisia, Navarretia, Leptodactylon,* and *Linanthus*—note that a genus included in this study, *Aliciella,* is a recent segregate genus, and was treated by Grant in *Gilia,* see Porter 1998). Although Grant acknowledges that "temperate tribes of Polemoniaceae . . . converge upon different tropical forms . . . [e.g.,] the Gilieae upon *Loeselia*" (Grant 1959: 197), he clearly considered the temperate tribes to represent two distinct lineages, each sharing common ancestry with different "tropical" genera. Previous molecular phylogenetic research (Steele and Vilgalys 1994; Johnson and Soltis 1995; Johnson et al. 1996; Porter 1996) has demonstrated that tribes Polemonieae and Gilieae are neither monophyletic nor "natural"; however, together they represent a single lineage, if *Loeselia* (of "tropical" tribe Bonplandieae) is also included. Mitochondrial *nad1b* sequences strongly support a clade that includes all of the sampled representatives of tribes Polemonieae and Gilieae (including the genus *Loeselia*), in concordance with these other studies. Further, *nad1b* sequences unambiguously and strongly suggest that the genus *Polemonium* is the sister to the remaining sampled members of Polemonieae, Gilieae, and *Loeselia. Bonplandia, Cantua,* and *Cobaea* are supported as monophyletic by *nad1*b intron sequences and are the sister group to the remaining Polemoniaceae. The monotypic genus *Acanthogilia* represents a lineage whose origin is during the early diversification of the family; however, its precise relationship relative to the *Bonplandia-Cantua-Cobaea* clade and the clade representing the remainder of Polemoniaceae is not strongly supported. The general pattern of early diversification supported by *nad* involves three primary lineages (relationships between these lineages are not well characterized): (a) a lineage including *Bonplandia, Cantua,* and *Cobaea*; (b) a lineage composed of the monotypic genus *Acanthogilia*; and (c) a lineage including *Loeselia* and genera of Polemonieae and Gilieae. This same pattern has been suggested based on analyses of cp *mat*K (Johnson et al. 1996), *ndh*F (Prather pers. comm.), and nuclear 18S rDNA (Johnson et al. 1998, in press).

Sister group relationships and Polemoniaceae.—A primary purpose of this research was to answer the question: what extant lineage is the sister group to Polemoniaceae? Mitochondrial *nad1b* intron sequences provide some insight into this question, but not a robust answer. When all indel characters are ignored (Analysis I), these data unambiguously support Fouquieriaceae as the sister group to Polemoniaceae. The support, however, is not strong. Treatment of indel characters with any increased weighting greatly weakens this relationship. In fact, if indels are considered twice as important as a single nucleotide substitution (not an unreasonable assumption), the sister group of Polemoniaceae is a lineage that includes Fouquieriaceae, Diapensiaceae, and Primulaceae.

The results of Analysis I are consistent with those of cp *matK* (Johnson et al. 1996) and nr 18S (Johnson et al. 1998, in press) sequence data. However, all these analyses, including *nad1b* intron sequences, only weakly support Fouquieriaceae as the sister group. Previous cp *rbcL* sequence data have been used to argue that Diapensiaceae is the sister group to Polemoniaceae (e.g., Olmstead et al. 1993), but more recent studies of *rbcL* data do not unambiguously support this relationship (Morton et al. 1997). Thus, while molecular data suggest sister group relationships involve Fouquieriaceae, Diapensiaceae, Primulaceae, and perhaps Styracaceae, the exact branching sequence is not clear. Taken together with this study, there is a growing consensus, albeit weak, from molecular data that Fouquieriaceae may be the sister group of Polemoniaceae.

Morphological Support?

Given the similar results from Analysis I of *nad1b* intron, *matK,* and 18S DNA sequences, it is tempting to cite morphological traits that also suggest relationship between Polemoniaceae and Fouquieriaceae. However, the assessment of homology is difficult because the ancestral condition of Polemoniaceae is not known. A "Catch 22" exists, in that accurate determination of ancestral states is greatly affected by outgroup selection and the exact branching sequence of the most closely related lineages. It is this branching order in which we still lack confidence. In addition, knowledge of the early branching events within Polemoniaceae are also required to assess ancestral character states. These too remain ambiguous. If we simply assume that Fouquieriaceae are the sister group, and ignore other closely related lineages or the internal branching within Polemoniaceae, a bias will result. For example, Hufford (1992) discusses the morphological similarity between *Acanthogilia* (of Polemoniaceae) and Fouquieriaceae. Hufford correctly points out that *Acanthogilia* and Fouquieriaceae both possess a "long-shoot/short-shoot" dimorphism. The primary leaves of the long shoot are at first green and photosynthetic, and later are retained on the stem as persistent spines. This compelling homology, upon closer inspection, appears dubious.

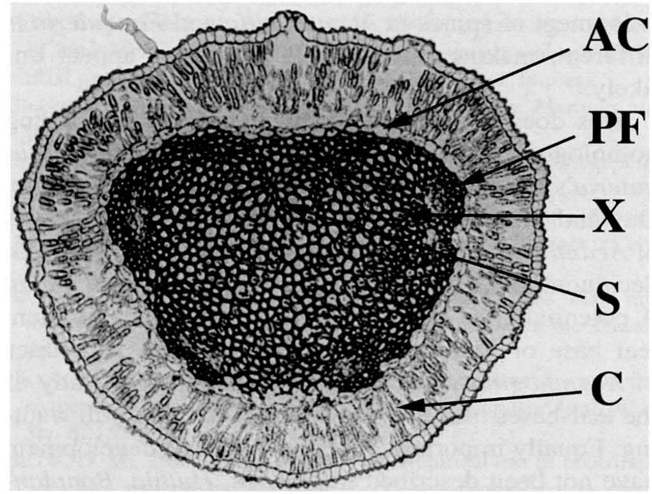

Fig. 5. Primary leaf histological cross section from the petiolar region of *Acanthogilia gloriosa.* A sheath of aqueous cells (AC) surrounds a central mass of sclerified tissue. The sclerified tissue is made up by the coalescence of vascular bundles and sclerenchyma (S). Identified are phloem fibers (PF), and vessels (V). Note the thin chlorenchyma (C) that, when desiccated, results in a persistent, pinnate spine.

In *Fouquieria,* the spine has its origin as a cylinder of fibers, continuous with the decurrent ridges of the stem. The petiole and lamina of the leaf are adaxial and fused to this fibrous cylinder (Riche 1922; Henrickson 1968). As the leaf matures, an abscission layer forms between the fibrous cylinder and the leaf. The laminar portion of the leaf eventually abscises, leading to the conclusion that the spine of *Fouquieria* represents a modification of the leaf base. In contrast, *Acanthogilia*'s persistent spines have a different origin.

Spines of *Acanthogilia* are formed by the lignification of the vascular system of the primary leaf (Fig. 5). The leaf vasculature of *Acanthogilia* occurs within a one-cell-layer-thick sheath of starch-rich, aqueous cells. Within the sheath is a series of vascular bundles, each with copious phloem fibers, a cluster of phloem tissue, a few xylem elements, and abundant fibers. The remaining parenchymatous tissue, within the sheath, develops secondary walls. In time, the thin chlorenchyma tissue dies, leaving the persistent, pinnatifid, fibrous vascular system. Therefore, in *Acanthogilia,* the spine represents a modification of the vascular system, not the leaf base as seen in *Fouquieria.* The development of spines in *Acanthogilia* and *Fouquieria* is different, making this putative homology appear unlikely.

This does not mean that there is no corresponding homologous trait in Polemoniaceae relative to *Fouquieria*'s modified, persistent leaf base. For example, Day and Moran (1986) describe the short-shoot leaves of *Acanthogilia* as possessing persistent leaf bases with deciduous blades, a feature also observed in *Cantua*. A potential homology may exist between the persistent leaf base of *Fouquieria* and the persistent leaf bases of *Acanthogilia* and *Cantua,* but histological study of the leaf-bases of *Acanthogilia* and *Cantua* is still wanting. Equally important, leaf and leaf-base development have not been described in *Cobaea, Huthia, Bonplandia,* and *Polemonium* in Polemoniaceae, nor in Diapensiaceae or Styracaceae, all of which are critical is assessing homology and ancestral conditions. A similar argument can be made for the long-shoot/short-shoot dimorphism, which also seems to be a homology shared by Polemoniaceae and Fouquieriaceae.

The description of the synapomorphies of Polemoniaceae and those shared between Polemoniaceae and their sister group is very important. This is a nontrivial pursuit, greatly complicated by our lack of knowledge of the exact branching order of the closest relatives of Polemoniaceae, and the structure of the early diversification within the family. Understanding homologies is also hampered by our limited comprehension of the comparative morphology of these taxa. This phylogenetic study, in combination with previous studies, while not providing complete picture of synapomorphies of Polemoniaceae and their sister group, does identify the taxa necessary for the evaluation of potential homologies.

Conclusions

This study demonstrates the general utility of mitochondrial DNA sequences of the *nad1b* intron for phylogenetic inference. This intron is comparable to chloroplast *rbcL* and nuclear 18S in the scale of phylogenetic resolution. We have examined the phylogenetic relationships of Polemoniaceae using this genic region. In common with previous molecular studies, *nad1b* sequences refute the traditional taxonomic classification of Polemoniaceae in or near Solananae. These sequences provide evidence that Polemoniaceae are instead related to Fouquieriaceae, Diapensiaceae, Primulaceae and Styracaceae, families classified in or near Theanae. The sister group to Polemoniaceae still remains elusive. Analysis of equal weighted nucleotide data, treating indels as unknown states, finds Fouquieriaceae as sister group; however, if indels are included and weighted, the sister group relationship changes. Although nr 18S, cp *matK,* and mt *nad1b* intron sequences have independently been used to infer Fouquieriaceae as the sister group, these analyses weakly infer this relationship and it should be considered tentative.

These mitochondrial data also are used to support the suggestion that early diversification of Polemoniaceae involved three lineages, the *Bonplandia–Cantua (Huthia)–Cobaea* clade, *Acanthogilia,* and a lineage including genera of Grant's (1959) Polemonieae, Gilieae, and *Loeselia.* The relationships between these lineages are not known. Because of the uncertainty in both the initial branching within Polemoniaceae and the branching pattern of most closely related lineages, assessment of homology between Polemoniaceae and other extant taxa remains problematic.

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Appendix 1. Aligned mitochondrial *nad1b* intron DNA sequences. The aligned nucleotide positions are given above the sequences, and the unaligned, cumulative length (excluding nucleotide positions coded "?") is given in the brackets, following the sequences, at the end of each line.

	10 20 30 40 50 60 70 80 90 100	
Oenothera berteriana	TGTGCGCCTTGTG.AGCGCGTTTGGATCCGCGAAGGCAATCGCTCGGATC.TTCCTCTAACCCAACCCGGGAACGGACCGGAGGGAACCGCAGCATGGGG	[98]
Carpenteria californica	TGTGCGCCTTGTG.AGCGCGTTTGGATCCGCGAAGGCAATCGCTCGGATG.TTCCCCTAACCCAACCCGGGAACGGACCGGAGGGAACCGCAGCATGGGG	[98]
Astragalus equisolensis	TGTGCGCCTTGTG.AGCGCGTTTGGATCCGCGAAGGCAATCGCTCGGATG.TTCCCCTAACCCAACCCGGGAACGGACCGGAGGGAACCGCAGCATGGGG	[98]
Viburnum sieboldii	TGTGCGCCTTGTG.AGCGCGTTTGGATCCGCGAAGGCAATCGCTCGGATG.TTCCCCTAACCCAACCCGGGAACGGACCGGAGGGAACCGCAGCATGGGG	[98]
Pholisma arenaria	TGTGCGCCTTGTG.AGCACGTTTGGATCCGCGAAGGCAATCGCTCGGATG.TTCCCCTAACCCAACCCGGGAACGGACCGGAGGGAACCGCAGCATGGGG	[98]
Petunia hybrida3704b	TGTGCGCCTTGTG.AGC.CGTTTGGATCCGCGAAGGCAATCGCTCGGATG.TTCCCCTAACCCAACCCGGGAACG.ACCGGAGG.AACCGCAGCATGGGG	[95]
Hymenoxys richardsonii	TGTGCGCCTTGTG.AGCGCGTTTGGATCCGCGAAGGAAATCGCTCGGATG.TTCCCCTAACCCAACCCGGGAACGGACCGGAGGGAACCGCAGCATGGGG	[98]
Hymenoxys hoopesii	AGTGCGCCTTGTG.AGCGCGTTTGGATCCGCGAAGGAAATCGCTCGGATG.TTCCCCTAACCCAACCCGGGAACGGACCGGAGGGAACCGCAGCATGGGG	[98]
Dodecatheon clevelandii	TGTGCGCCTTGTG.AGCGCGTTTGGATCCGCGAAGGCAATCGCTCGGATG.TTCCCCTAACCCAACCCGGGAATGGACCGGAGGGAACCGCAGCATGGGG	[98]
Anagallis arvensis	TGTGCGCCTTGTG.AGCGCGTTTGGATCCGCGAAGGCAATAGCTCGGATG.TTCCCCTAACCCAACCCGGGAATGGACCGGAAGGAACCGCAGCATGGGG	[98]
Ornithostaphylos oppositifolia	TGTGCGCCTTGTG.AGCGCGTTTGGATCCGTGAAGGCAATCGCTCGGATG.TTCCCCTAACCCAACCCGGGAACGGACCGGAGGGAACCGCAGCATGGGG	[98]
Styrax redivivus	TGTGCGCCTTGTGGAGCGCGTTTGGATCCGCGAAGGCAATCGCTCGGATG.TTACCCTAACCCAACCCGGGAACGGACCGGAGGGAACCGCAGCATGGGG	[99]
Diapensia lapponica	TGTGCGCCTTGTG.AGCGCGTTTGGATCCGCGAAGGTAATCGCTCGGATG.TTCCCCTAACCCAACCCGGGAACGGACCGGAGGGAACCGCAGCATGGGG	[98]
Fouqueria splendens	TGTGTGTCTTGTG.AGCGCGTTTGGATCCGGGATGGCAATCGCTCGGATG.TTCCCCTAACCCAACCCGGGAACGGACCGGAGGGAACCGCAGCATGGGG	[98]
Bonplandia geminiflora	TGTGCGCCTTGTG.AGCGCGTTTGGATCCGCGAAGGCAACCGCTCGGATGGTTCCCCTAACCCAACCCGGGAACGGACCGGGGGAACCGCAGCATGGGG	[99]
Cantua quercifolia	TGTGCGCCTTGTG.AGCGCGTTTGGATCCGCGAAGGCAACCGCTCGGATGGTTCCCCTAACCCAACCCGGGAACGGACCGGGGGAACCGCAGCATGGGG	[99]
Cobaea scandens	TGTGCGCCTTGTG.AGCGCGTTTGGATCCGCGAAGGCAACCGCTCGGATGGTTCCCCTAACCCAACCCGGGAACGGACCGGGGGAACCGCAGCATGGGG	[99]
Acanthogilia gloriosa	TGTGCGCCTTGTG.AGCGCGTTTGGATCCGCGAAGGCAACCGCTCGGATGGTTCCCCTAACCCAACCCGGGAACGGACCGGGGGAACCGCAGCATGGGG	[99]
Polemonium formosissimum	TGTGTGCCTTGTG.AGCGCGTTTGGATCCGCGAAGGCAACCGCTCGGATGGTTCCCCTAACCCAACCCGGGAACGGACCGGGGGGACCGCAGCATGGGG	[99]
Gilia splendens	TGTGCGCCTTGTG.AGCGCGTTTGGATCCGCGAAGGCAACCGCTCGGATGGTTCCCCTAACCCAACCCGGGAACGGACCGGGGGGACCGCAGCATGGGG	[99]
Collomia grandiflora	TGTGCGCCTTGTG.AGCGCGTTTGGATCCGCGAAGGCAACCGCTCGGATGGTTCCCCTAACCCAACCCGGGAACGGACCGGGGGGACCGCAGCATGGGG	[99]
Allophyllum gilioides	TGTGCGCCTTGTG.AGCGCGTTTGGATCCGCGAAGGCAACCGCTCGGATGGTTCCCCTAACCCAACCCGGGAACGGACCGGGGGGACCGCAGCATGGGG	[99]
Ipomopsis aggregata	TGTGCGCCTTGTG.AGCGCGTTTGGATCCGCGAAGGCAACCGCTCGGATGGTTCCCCTAACCCAACCCGGGAACGGACCGGGGGGACCGCAGCATGGGG	[99]
Loeselia glandulosa	TGTGCGCCTTGTG.AGCGCGTTTGGATCCGCGAAGGCAACCGCTCGGATGGTTCCCCTAACCCAACCCGGGAACGGACCGGGGGGACCGCAGCATGGGG	[99]
Aliciella micromeria	TGTGCGCCTTGTG.AGCGCGTTTGGATCCGCGAAGGCAACCGCTCGGATGGTTCCCCTAACCCAACCCGGGAACGGACCGGGGGGACCGCAGCATGGGG	[99]
Aliciella subnuda	TGTGCGCCTTGTG.AGCGCGTTTGGATCCGCGAAGGCAACCGCTCGGATGGTTCCCCTAACCCAACCCGGGAACGGACCGGGGGGACCGCAGCATGGGG	[99]
Aliciella mcvickerae	TGTGCGCCTTGTG.AGCGCGTTTGGATCCGCGAAGGCAACCGCTCGGATGGTTCCCCTAACCCAACCCGGGAACGGACCGGGGGGACCGCAGCATGGGG	[99]
Aliciella latifolia	TGTGCGCCTTGTG.AGCGCGTTTGGATCCGCGAAGGCAACCGCTCGGATGGTTCCCCTAACCCAACCCGGGAACGGACCGGGGGGACCGCAGCATGGGG	[99]
Gilia cf. scabra	TGTGCGCCTTGTG.AGCGCGTTTGGATCCGCGAAGGCAACCGCTCGGATGGTTCCCCTAACCCAACCCGGGAACGGACCGGGGGGACCGCAGCATGGGG	[99]
Linanthus nuttallii	TGTGCGCCTTGTG.AGCGCGTTTGGATCCGCGAAGGCAACCGCTCGGATGGTTCCCCTAACCCAACCCGGGAACGGACCGGGGGGACCGCAGCATGGGG	[99]
Phlox gracilis	TGTGCGCCTTGTG.AGCGCGTTTGGATCCGCGAAGGCAACCGCTCGGATGGTTCCCCTAACCCAACCCGGGAACGGACCGGGGGGACCGCAGCATGGGG	[99]
Leptodactylon pungens	TGTGCGCCTTGTG.AGCGCGTTTGGATCCGCGAAGGCAACCGCTCGGATGGTTCCCCTAACCCAACCCGGGAACGGACCGGGGGGACCGCAGCATGGGG	[99]

Appendix 1. Continued.

	110 . 120 . 130 . 140 . 150 . 160 . 170 . 180 . 190 . 200 .	
Oenothera berteriana	AATGTCCGCGTCTCGTCGCAAGGCTCATTTTGAGTTGTGGGTCATAGGGCGCGCTTCGGGCGGGCAGCTTTATCTGATCAAG....GGCCGGGGCACAAG	[194]
Carpenteria californica	AATGTCCGCGTCTCGTCGCAAGGCTCATTTTGAGTTGTGGGTCATAGGGCGGGCTTCGGGCGGGCAGCTTTATCTGATCAAG....GGCCGGGGCACAAG	[194]
Astragalus equisolensis	AATGTCCGCGTCTCGTCGCAAGGCTCATTTTTAGTTTTTGGTCATA..........AGGCGGGCGGATTTATCTGATCAAG....GGCCGGGGCACAAG	[183]
Viburnum sieboldii	AATGTCCGCGTCTCGTCGCAAGGCTCATTTTGAGTTGTGGGTCATA..........GGGCGGGCAGCTTTCTCTGATCAAG....GGCCGGGGCACAAG	[183]
Pholisma arenaria	AATGTCCGTGTCTCGTCGCAAGGCTCATTTTTT.TTGTGGGTCATA..........GGGCGGGCAGCTTTATCTGATTAAG....GGCCGGGGCACAGG	[182]
Petunia hybrida3704b	AATGTCCGCGTCTCGTCGCAAGGCTCATTTTGAGTTGTGGGTCATA..........AGGCGGGCAGCTTTATCTGAGCAAG....GGCCGGGGCACAAG	[180]
Hymenoxys richardsonii	AATGTCCGCGTCTCGTCGCAAGGCTCATTTTGAGTTGTGGGTCATA..........GGGCGGGCAGCTTTATCTGATCAAA....GGCCGGGGCACAAG	[183]
Hymenoxys hoopesii	AATGTCCGCGTCTCGTCGCAAGGCTCATTTTGAGTTGTGGGTCATA..........GGGCGGGCAGCTTTATCTGATCAAA....GGCCGGGGCACAAG	[183]
Dodecatheon clevelandii	AATGTCCGCGTCTTGTCGCAAGGCTCATTTTTAGTTGTGGGTCATA..........GGGCGGGCAGCTTTCTCTGATCAAACAAAGACCGGGGCACAAG	[187]
Anagallis arvensis	AATGTCCGCGTCTCGTCGCAAGGCTCATTTTGAGTTGTGGGTCATA..........GGGCGGGCAGCTTTCTCTGATCAAACAAAGACCGGGGCACAAG	[187]
Ornithostaphylos oppositifolia	AATGTCCGCGTCTCGTCGCAAGGCTCATTTGGAGTTGTGGGTCATAGGGCGGGCTTCGGGCCGGCAGCTTTATCTGAAAAAA....GGCCGGGGCACAAG	[194]
Styrax redivivus	AATGTCCGCGTCTCGTCGCAAGGCTCATTTTTAGTTGTGGGTCATAGGGCGGGCTTCGGGCGGGCAGCTTTATCTGACCAAA....GGCCGGGGCACAAG	[195]
Diapensia lapponica	AATGTCCGCGTCTCGTCGCAAGGCTCATTTTTTGTTGTGGGTTATA..........GGGCGGGCAGCTTTCTTTTATCAAA....GGCCGGGGCACAAG	[183]
Fouqueria splendens	AATGTCCGCGTCTCGTCGCAAGGGTCATTTTTAGTTGTGGGTCATA..........GGGCGGGCTGCTTTATCTGATCAAA....GGCCGGGGCACAAG	[183]
Bonplandia geminiflora	AATGTCCGCGTCTCGTCGCAAGGCTCATTTTGAGTTGTGGGTCATAGGGCGGACTTCGGGCGGGCAGCTTTATCTGATCAAA....GGCCGGGGCACAAG	[195]
Cantua quercifolia	AATGTCCGCGTCTCGTCGCAAGGCTCATTTTGAGTTGTGGGTCATAGGGCGGACTTCGGGCGGGCAGCTTTATCTGATCAAA....GGCCGGGGCACAAG	[195]
Cobaea scandens	AATGTCCGCGTCTCGTCGCAAGGCTCATTTTGAGTTGTGGGTCATAGGGCGGACTTCGGGCGGGCAGCTTTATCTGATCAAA....GGCCGGGGCACAAG	[195]
Acanthogilia gloriosa	AATGTCCGCGTCTCGTCGCAAGGCTCATTTTGAGTTGTGGGTCATAGGGCGGACTTCGGGCGGGCAGCTTTATCTGATCAAA....GGCCGGGGCACAAG	[195]
Polemonium formosissimum	AATGTCCGCGTCTCGTCGCAAGGCTCATTTTGAGTTGTGGGTCATAGGGCGGACTTCGGGCGTGCAGCTTTATCTGATCAAA....GGCCGGGGCACAAG	[195]
Gilia splendens	AATGTCCGCGTCTCGTCGCAAGGCTCATTTTGAGTTGTGGGTCATAGGGCGGACTTCGGGCGGGCAGCTTTATCTGATCAAA....GGCCGGGGCACAAG	[195]
Collomia grandiflora	AATGTCCGCGTCTCGTCGCAAGGCTCATTTTGAGTTGTGGGTCATAGGGCGGACTTCGGGCGGGCAGCTTTATCTGATCAAA....GGCCGGGGCACAAG	[195]
Allophyllum gilioides	AATGTCCGCGTCTCGTCGCAAGGCTCATTTTGAGTTGTGGGTCATAGGGCGGACTTCGGGCGGGCAGCTTTATCTGATCAAA....GGCCGGGGCACAAG	[195]
Ipomopsis aggregata	AATGTCCGCGTCTCGTCGCAAGGCTCATTTTGAGTTGTGGGTCATAGGGCGGACTTCGGGCGGGCAGCTTTATCTGATCAAA....GGCCGGGGCACAAG	[195]
Loeselia glandulosa	AATGTCCGCGTCTCGTCGCAAGGCTCATTTTGAGTTGTGGGTCATAGGGCGGACTTCGGGCGGGCAGCTTTATCTGATCAAA....GGCCGGGGCACAAG	[195]
Aliciella micromeria	AATGTCCGCGTCTCGTCGCAAGGCTCATTTTGAGTTGTGGGTCATAGGGCGGACTTCGGGCGGGCAGCTTTATCTGATCAAA....GGCCGGGGCACAAG	[195]
Aliciella subnuda	AATGTCCGCGTCTCGTCGCAAGGCTCATTTTTAGTTGTGGGTCATAGGGCGGACTTCGGGCGGGCAGCTTTATCTGATCAAA....GGCCGGGGCACAAG	[195]
Aliciella mcvickerae	AATGTCCGCGTCTCGTCGCAAGGCTCATTTTTAGTTGTGGGTCATAGGGCGGACTTCGGGCGGGCAGCTTTATCTGATCAAA....GGCCGGGGCACAAG	[195]
Aliciella latifolia	AATGTCCGCGTCTCGTCGCAAGGCTCATTTTGAGTTGTGGGTCATAGGGCGGACTTCGGGCGGGCAGCTTTATCTGATCAAA....GGCCGGGGCACAAG	[195]
Gilia cf. scabra	AATGTCCGCGTCTCGTCGCAAGGCTCATTTTGAGTTGTGGGTCATAGGGCGGACTTCGGGCGGGCAGCTTTATCTGATCAAA....GGCCGGGGCACAAG	[195]
Linanthus nuttallii	AATGTCCGCGTCTCGTCGCAAGGCTCATTTTGAGTTGTGGGTCATAGGGCGGACTTCGGGCGGGCAGCTTTATCTGATCAAA....GGCCGGGGCACAAG	[195]
Phlox gracilis	AATGTCCGCGTCTCGTCGCAAGGCTCATTTTTAGTTGTGGGTCATAGGGCGGACTTCGGGCGGGCAGCTTTATCTGATCAAA....GGCCGGGGCACAAG	[195]
Leptodactylon pungens	AATGTCCGCGTCTCGTCGCAAGGCTCATTTTGAGTTGTGGGTCATAGGGCGGACTTCGGGCGGGCAGCTTTATCTGATCAAA....GGCCGGGGCACAAG	[195]

Appendix 1. Continued.

	210 220 230 240 250 260 270 280 290 300	
	. . . .	
Oenothera berteriana	GGTCCTGGTACTATCCAGGTGCGAAGAACCC.GGAGGTGACTGCAA.TGAGCAGAAATCCCACTCACCGGCCTAAACGACGAGCAAACACTCGAACGTGA	[292]
Carpenteria californica	GGTCCTGGTACTATCCAGGTGCGAAGAACCCCGGAGGTGACTGCAA.TGAGCAGAAATCTCACTCACCGGCCTAAACGACGAGCAAACACTCGAACGTGA	[293]
Astragalus equisolensis	GGTCCTGGTACTATCCAGGTGCGAAGAACCCCGGAGGTGACTGCAA.TGAGCAGAAATCTCACTCACCGGCCTAAACGACGAGCAAACACTCGAACGTGA	[282]
Viburnum sieboldii	GGTCCTGGTACTATCCAGGTGCGAAGAACCCCGGAGGTGACTGCAA.TGAGCAGAAATCTCACTCACCGGCCTAAACGACGAGCAAACACTCGAACGTGA	[282]
Pholisma arenaria	GGTCCTGGTACTATCCAGGTGCGAAGAACCCCGGAGGTGACTGCAA.TGAGCAGAAATCTCACTCACGGGCCTAAACGACGACCAAAGACTCGAACGTGA	[281]
Petunia hybrida3704b	GGTCCTGGTACTATCCAGGTGCGAAGAACCCCGGAGGTGACTGCAA.TGAGCAGAAATCTCACTCACGGGCCTAAACGACGAGCAAACACTCGAACGTGA	[279]
Hymenoxys richardsonii	GGTCCTAGTACTATCCAGGTGCGAAGAAGCCCGGAGGTGACTGCAA.TGAGCAGAAATCTCACTCACCGGCCTAAACGACGAGCAAACACTCGAACGTGA	[282]
Hymenoxys hoopesii	GGTCCTAGTACTATCCAGGTGCGAAGAAGCCCGGAGGTGACTGCAA.TGAGCAGAAATCTCACTCACCGGCCTAAACGACGAGCAAACACTCGAACGTGA	[282]
Dodecatheon clevelandii	GGTCCTGGTACTATCCAGGTGCGAAAAACCCCGGAGGTGACTGCAA.TGAGCAGAAATATAACTCACCGGCCTAAACGACGAGCAAACACTCGAACGTGA	[286]
Anagallis arvensis	GGTCCTGGTACTATCCAGGTGCGAAAAACCCCGGAGGTGACTGCAA.TGAGCAGAAATCTCACTCACCGGCCTAAACGACGAGCAAACACTCGAACGTGA	[286]
Ornithostaphylos oppositifolia	GGTCCTGGTACTATCCAGGTGCGAAGAACCCCGGAGGTGACTGCAA.TGAGCAGAAATCTCACTCACCGGCCTAAACGACGAGCAAACACTCGAACGTGA	[293]
Styrax redivivus	GGTACTGGTACTATCCAGGTGCGAAGAACCCCGGGGGTGACTGCAA.TGAGCAGAAATCTCACTCACCGGCCTAAACGACGAGCAAACACTCGAACGTGA	[294]
Diapensia lapponica	GGTCCTGGTACTATCCAGGTGCGAAGAACCCCGGAGGTGACTGCAA.TGAGCAGAAATCTCACTCACCGGCCTAAACGACGAGCAAAGACTCTCACGTTA	[282]
Fouqueria splendens	GGTCCTGGTACTATCCAGGTGCGAAGAACCCCGGAGGTGACTGCAA.TGAGCAGAAATCTCACTCACCGGCCTAAACGACGAGCAAACACTCGAACGTGA	[282]
Bonplandia geminiflora	GGTCCTGGTACTATCCAGGTGCGAAGAACCCCGGAGGTGACTGCAA.TGAGCAGAAATCTCACTCACCGGCCTAAACGACGAGCAAACACTCGAACGTGA	[294]
Cantua quercifolia	GGTCCTGGTACTATCCAGGTGCGAAGAACCCCGGAGGTGACTGCAA.TGAGCAGAAATCTCACTCACCGGCCTAAACGACGAGCAAACACTCGAACGTGA	[294]
Cobaea scandens	GGTCCTGGTACTATCCAGGTGCGAAGAACCCCGGAGGTGACTGCAA.TGAGCAGAAATCTAACTCACCGGCCTAAACGACGAGCAAACACTCGAACGTGA	[294]
Acanthogilia gloriosa	GGTCCTGGTACTATCCAGGTGCGAAGAACCCCGGAGGTGACTGCAA.TGAGCAGAAATCTCACTCACCGGCCTAAACGACGAGCAAACACTCGAACGTGA	[294]
Polemonium formosissimum	GGTCCTGGTACTATCCAGGTGCGAAGAACCCCGGAGGTGACTGCAAATGAGCAGAAATCTCACTCACCGGCCTAAACGACGAGCAAACACTCGAACGTGA	[295]
Gilia splendens	GGTCCTGGTACTATCCAGGTGCGAAGAACCCCGGAGGTGACTGCAA.TGAGCAGAAATCTCACTCACCGGCCTAAACGACGAGCAAACACTCGAACGTGA	[294]
Collomia grandiflora	GGTCCTGGTACTATCCAGGTGCGAAGAACCCCGGAGGTGACTGCAA.TGAGCAGAAATCTCACTCACCGGCCTAAACGACGAGCAAACACTCGAACGTGA	[294]
Allophyllum gilioides	GGTCCTGGTACTATCCAGGTGCGAAGAACCCCGGAGGTGACTGCAA.TGAGCAGAAATCTCACTCACCGGCCTAAACGACGAGCAAACACTCGAACGTGA	[294]
Ipomopsis aggregata	GGTCCTGGTACTATCCAGGTGCGAAGAACCCCGGAGGTGACTGCAA.TGAGCAGAAATCTCACTCACCGGCCTAAACGACGAGCAAACACTCGAACGTGA	[294]
Loeselia glandulosa	GGTCCTGGTACTATCCAGGTGCGAAGAACCCCGGAGGTGACTGCAA.TGAGCAGAAATCTCACTCACCGGCCTAAACGACGAGCAAACACTCGAACGTGA	[294]
Aliciella micromeria	GGTCCTGGTACTATCCAGGTGCGAAGAACCCCGGAGGTGACTGCAA.TGAGCAGAAATATCACTCACCGGCCTAAACGACGAGCAAACACTCGAACGTGA	[294]
Aliciella subnuda	GGTCCTGGTACTATCCAGGTGCGAAGAACCCCGGAGGTTACTGCAA.TGAGCAGAAATCTCACTCACCGGCCTAAACGACGAGCAAACACTCGAACGTGA	[294]
Aliciella mcvickerae	GGTCCTGGTACTATCCAGGTGCGAAGAACCCCGGAGGTGACTGCAA.TGAGCAGAAATCTCACTCACCGGCCTAAACGACGAGCAAACACTCGAACGTGA	[294]
Aliciella latifolia	GGTCCTGGTACTATCCAGGTGCGAAGAACCCCGGAGGTGACTGCAA.TGAGCAGAAATCTCACTCACCGGCCTAAACGACGAGCAAACACTCGAACGTGA	[294]
Gilia cf. scabra	GGTCCTGGTACTATCCAGGTGCGAAGAACCCCGGAGGTGACTGCAA.TGAGCAGAAATCTCACTCACCGGCCTAAACGACGAGCAAACACTCGAACGTGA	[294]
Linanthus nuttallii	GGTCCTGGTACTATCCAGGTGCGAAGAACCCCGGAGGTGACTGCAA.TGAGCAGAAATCTCACTCACCGGCCTAAACGACGAGCAAACACTCGAACGTGA	[294]
Phlox gracilis	GGTCCTGGTACTATCCAGGTGCGAAGAACCCCGGAGGTGACTGCAA.TGAGCAGAAATCTCACTCACCGGCCTAAACGACGAGCAAACACTCGAACGTGA	[294]
Leptodactylon pungens	GGTCCTGGTACTATCCAGGTGCGAAGAACCCCGGAGGTGACTGCAA.TGAGCAGAAATCTCACTCACCGGCCTAAACGACGAGCAAACACTCGAACGTGA	[294]

Appendix 1. Continued.

	310 320 330 340 350 360 370 380 390 400	
Oenothera berteriana	GAGCAAGGGATCACCCGACGAATGGACGAGCTCCAA..GGAGGGAGG...	[337]
Carpenteria californica	GAGCAAGGGATCACCCAACGAATGGACGAGCTCCAA..GGAGGGAGG...	[338]
Astragalus equisolensis	GAGCAAGGGATCACCTAACGAATGGACGAGCTCCAA..GGAGGGAGG...	[327]
Viburnum sieboldii	GAGCAAGGGATCACCCAACGAATGGACGAGCTCAAA..GGGGGGAGG...	[327]
Pholisma arenaria	GAGCAAGGGATCACCCAACGAATGGACGAGCTCAAA..GGGGGAGGG...	[326]
Petunia hybrida3704b	GAGCAAGGGATCACCCAACGAATGGACGAGCTCAAA..GGGGGGAGG...	[324]
Hymenoxys richardsonii	GAGCAAGGGATCACCCAACGAATGGACGAGCTCAAA..GGGGGGAGG...	[327]
Hymenoxys hoopesii	GAGCAAGGGATCACCCAACGAATGGACGAGCTCAAA..GGGGGGAGG...	[327]
Dodecatheon clevelandii	GAACAAGGGATCACCCAACGAATGGACGAACTCCAA..GG..	[324]
Anagallis arvensis	GAACAAGGGATCACCCAACGAATGGACGAGCTCCAA..GG..	[324]
Ornithostaphylos oppositifolia	GAGCAAGGGATCACCCAACGAATGGACGAGCTCCAA..GGAGGGAGG...	[338]
Styrax redivivus	GAGCAAGGGATCACCCAACGAATGGACGAGCTCCAA..GAAGGGAGG...	[339]
Diapensia lapponica	GAGCAAGGGATCACCCAACGAATGGACGAACTCCAA..GGAGGGAGG...	[327]
Fouqueria splendens	GAGCAAGGGATCACCCAACGAATGGACGAGCTCCAAC.GGAGGGAGG...	[328]
Bonplandia geminiflora	GAGCAAGGGATCACCCAACGATAGAGAGAGGCG.AACATGAGGGAGG...	[340]
Cantua quercifolia	GAGCAAGGGATCACCCAACGATAGAGAGAGGCG.AACATGAGGGAGG...	[340]
Cobaea scandens	GAGCAAGGGATCACCCAACGATAGAGAGAGGCG.AACATGAGGGAGG...	[340]
Acanthogilia gloriosa	GAGCAAGGGATCACCCAACATTAGAGAGAGGCG.AACATGAGGGAGG...	[340]
Polemonium formosissimum	GAGCAAGGGATCACCCAACGATAGAGAGAGGCG.AACATGAGGGGGC...	[341]
Gilia splendens	GAGCAAGGGATCACCCAACGATAGAGAGAGGAG.AACATGAGGGAGCCACCGGAGGCTAAAGGCCTATGACTTGAGGGCCTGAGTACTACGTGCGAGGGC	[393]
Collomia grandiflora	GAGCAAGGGATCACCCAACGATAGAGAGAGGCG.AACATGAGGGAGCCACCGGAGGCGAAAGCCCTCTCACTTGAGGGACTGAGTACTACGTTAGAGGGC	[393]
Allophyllum gilioides	GAGCAAGGGATCACCCAACGATAGAGAGAGGCG.AACATGAGGGAGCCACCGGAGGCTAAAGC.....................................	[356]
Ipomopsis aggregata	GAGCAAGGGATCACCCAACGATAGAGAGAGGCG.AACATGAGGGAGG...	[340]
Loeselia glandulosa	GAGCAAGGGATCACCCAACGATAGAGAGAGGAG.AACATGAGGGAGG...	[340]
Aliciella micromeria	GAGCAAGGGATCACCCAACGATAGAGAGAGGCG.AACATGAGGGAGG...	[340]
Aliciella subnuda	AAGCAAGGGATCACCCAACGATAGAGAGAGGCG.AACATGAGGGAGG...	[340]
Aliciella mcvickerae	GAGCAAGGGATCACCCAACGATAGAGAGAGGCG.AACATGAGGGAGG...	[340]
Aliciella latifolia	GAGCAAGGGATCACCCAACGATAGAGAGAGGCG.AACATGAGGGAGG...	[340]
Gilia cf. scabra	GAGCAAGGGATCACCCAACGATAGAGAGAGGCG.AACATGAGGGAGG...	[340]
Linanthus nuttallii	GAGCAAGGGATCACCCAACGATAGAGAGAGGCG.AACATGAGGGAGCAACACGAGAGGCTCAAG....................................	[357]
Phlox gracilis	GAGCAAGGGATCACCCAACGATAGAGAGAGGCG.AACATGAGGGAGG...	[340]
Leptodactylon pungens	GAGCAAGGGATCACCCAACGATAGAGAGAGGCG.AACATGAGGGAGC..CACCGGAGGCTAAAG....................................	[355]

Appendix 1. Continued.

	410 420 430 440 450 460 470 480 490 500	
Oenothera berteriana	....AGAGA	[342]
Carpenteria californica	....AGAGA	[343]
Astragalus equisolensis	....	[327]
Viburnum sieboldii	....AGAGA	[332]
Pholisma arenaria	....	[326]
Petunia hybrida3704b	....	[324]
Hymenoxys richardsonii	....AGAGA	[332]
Hymenoxys hoopesii	....AGAGA	[332]
Dodecatheon clevelandii	....AGAGA	[329]
Anagallis arvensis	....AGAGA	[329]
Ornithostaphylos oppositifolia	....AGAGA	[343]
Styrax redivivus	....AGAGA	[344]
Diapensia lapponica	....AGAGA	[332]
Fouqueria splendens	....AGAGA	[333]
Bonplandia geminiflora	....AGAGA	[345]
Cantua quercifolia	....AGAGA	[345]
Cobaea scandens	....AGAGA	[345]
Acanthogilia gloriosa	....AGAGA	[345]
Polemonium formosissimum	....	[341]
Gilia splendens	GGTCGTAGATCGGCTCGACCAATAGGGAGAGGGTAAA.........GGGAGTAGATCATCGAACGTGAGTGAGAGCCCTT.GATCCTAACCCTCCGTACC	[483]
Collomia grandiflora	.......AAAGCACTCGACCAATAGGGAGAGGGTGGTCGTAGATCAGGGAGTAGATCATCGAACGTTAGTGAGAGCCACCGGAGGCTAAAG.........	[477]
Allophyllum gilioides	....	[356]
Ipomopsis aggregata	....AGAGA	[345]
Loeselia glandulosa	....AGAGA	[345]
Aliciella micromeria	....AGAGA	[345]
Aliciella subnuda	....AGAGA	[345]
Aliciella mcvickerae	....AGAGA	[345]
Aliciella latifolia	....AGAGA	[345]
Gilia cf. scabra	....AGAGA	[345]
Linanthus nuttallii	....	[357]
Phlox gracilis	....AGAGAGGGGGGCAGAGA	[357]
Leptodactylon pungens	....	[355]

Appendix 1. Continued.

	510 520 530 540 550 560 570 580 590 600	
Oenothera berteriana	GGAAGGCAAGAACCATACTTTCAGAGAGGTG.......GCGGTCTGAATCAACTCTGAACTGCGAGAATAACTGACTAAGCCGTGCCATAAGGGG.....	[430]
Carpenteria californica	GGGGGGCAAGAACCATGCTTTCAGAGAAGTG.......GCGGTCCGAATCTTATCTGAACTGCGAGAATAACTGACTAAGCCGTGCCATAAGGGG.....	[431]
Astragalus equisolensis	..AAGGCAAGAACCATGCTTTCAGAGAAGTG.......GCGGTCCGAATCTTATCTGAACTGCGAGAATAACTGACTAAGCCATGCCATAAGGG......	[412]
Viburnum sieboldii	GGGGGGCAAGAACCATGCTTTCAGAGACCACACCCAACCCGGTCCGAATCTTATCTGAACTGCGAGAATAACTGACTAAGCCGTGCCATAAGGGG.....	[427]
Pholisma arenaria	....GGCCAGAACCATGCTTTCAGAGACCTAACCCAACCCGGTCCGAATCTTATCTGAACTGCGAGAATAACTGACTAAGCCGTGCCATGCC.ATAAGGG	[421]
Petunia hybrida3704b	..GAGGCAAGAACCATGCTTTCAGAGACCTAACCCAACCCGGTCCGAATCTTATCTGAACTGCGAGAATAACTGACTAAGCCGTGCCATAAGGGG.....	[417]
Hymenoxys richardsonii	GGGGGGCAAGAACCATGTTTTCAGAGAAGTG.......GCGGTCCGAATCTTATCTGAACTGCGAGAATAACTTACTAAGCCGTGCCATAAGGG......	[419]
Hymenoxys hoopesii	GGGGGGCAAGAACCATGTTTTCAGAGAAGTG.......GCGGTCCGAATCTTATCTGAACTGCGAGAATAACTTACTAAGCCGTGCCATAAGGG......	[419]
Dodecatheon clevelandii	GGGGGGCAAGAACCATGCTTTCAGAGAAGTG.......GCGGTCCGAATCTTATCTGAACTGCGAGAATAACTGACTAAGCCGTGCCATAAGGGG.....	[417]
Anagallis arvensis	GGGGGGCAAGAACCATGCTTTCAGAGAAGTG.......GCGGTCCGAATCTTATCTGAACTGCGAGAATAACTGACTAAGCCGTGCCATAAGGGG.....	[417]
Ornithostaphylos oppositifolia	GGGGGGCAAGAACCATGCTTTCAGAGAAGTG.......GCGGTCCGAATCTTATCGAAACTGCGAGAATAACTGGCTAAGCCGTGCCATAAGGGG.....	[431]
Styrax redivivus	GGAGGGCAAGAACCATGCTTTCAGAGAAGTG.......GCGGTCCGAATCTTATCTGAACTGCGAGAATCACTGACTAAGCCCTGCCATAAGGGG.....	[432]
Diapensia lapponica	GGGGGGCAAGAAAGATGCTTTCAGAGAAGTG.......GCGGTCCGAATCTTATCTGAACTTCGAGAATAACTGACTAAGCCGTGCCGTAAAGGG.....	[420]
Fouqueria splendens	GGGGGGCAAGAACCATGCTTTCAGAGAAGTG.......GCGGTCCTAATCTTATCTGAACTGCGAGAATAACTGACTAAGCCGTGCCATAAGGGG.....	[421]
Bonplandia geminiflora	GGGGGGCAAGAACCATGCTTTCAGAGACCTAACCCAACCCGGTCCAAATCTTATATGAACTGCGATAATAACTTACTAAGCCGTGCCATAGGGGG.....	[440]
Cantua quercifolia	GGGGGGCAAGAACCATGCTTGAAGAGAAGTG.......GCGGTCAAAATCTTATCTGAACTGCGAGAATAACTGACTAAGCCGTGCCATAGGGGG.....	[433]
Cobaea scandens	GGGGGGCAAGAACCATGCTTTCAGAGAAGTG.......GCGGTCCAAATCTTATCTGAACTGCGAGAATAACTGACTAAGCCGTGCCATAGGGGG.....	[433]
Acanthogilia gloriosa	GGGGGGCAAGAACCATGCTTTCAGAGAAGTG.......GCGGTCCAAATCTTATCTGAACTGCGAGAATAACTGACTAAGCCGTGCCATAGGGGG.....	[433]
Polemonium formosissimum	GGGGGGCAAGAACCATGCTTTCAGAGAAGTG.......GCGGTCCAAATCTTATCTGAACTGCGAGAATAACTGACTAAGCCGTGCCATAGGGGG.....	[429]
Gilia splendens	GGGGGGCAAGAACCATGCTTTCAGAGAAGTG.......GCGGTCCAAATCTTATCTGAACTGCGAGAATAACTGACTAAGCCGTGCCATAGCCACCGGAG	[576]
Collomia grandiflora	.......AAGAACCATGCTTTCAGAGAAGTG.......GCGGTCCAAATCTTATCTGAACTGCGAGAATAACTGACTAAGCCGTGCCATAGCCACCGGAG	[563]
Allophyllum gilioides	....	[356]
Ipomopsis aggregata	GGGGGGCAAGAACCATGCTTTCAGAGAAGTG.......GCGGTCCAAATCTTATCTGAACTGCGAGAATAACTGACTAAGCCGTGCCATAGCCACCGGAG	[438]
Loeselia glandulosa	GGGGGGCAAGAACCATGCTTTCAGAGAAGTG.......GCGGTCCAAATCTTATCTGAACTGCGAGAATAACTGACTAAGCCGTGCCATAGCCACCGGAG	[438]
Aliciella micromeria	GGGGGGCAAGAACCATGCTTTCAGAGAAGTG.......GCGGTCCAAATCTTATCTGAACTGCGAGAATAACTGACTAAGCCGTGCCATAGCCACCGGAG	[438]
Aliciella subnuda	GGGGGGCAAGAACCATGCTTTCAGAGAAGTG.......GCGGTCCAAATCTTATCTGAACTGCGAGAATAACTGACTAAGCCGTGCCATAGCCACCGTAG	[438]
Aliciella mcvickerae	GGGGGGCAAGAACCATGCTTTCAGAGAAGTG.......GCGGTCAAAATCTTATCTGAACTGCGAGAATAACTGACTAAGCCGTGCCATAGCCACCGGAG	[438]
Aliciella latifolia	GGGGGGCAAGAACCATGCTTTCAGAGAAGTG.......GCGGTCCAAATCTTATCTGAACTGCGAGAATAACTGACTAAGCCGTGCCATAGCCACCGGAG	[438]
Gilia cf. scabra	GGGGGGCAAGAACCATGCTTTCAGAGAAGTG.......GCGGTCCAAATCTTATCTGAACTGCGAGAATAACTGACTAAGCCGTGCCATAGCCACCGGAG	[438]
Linanthus nuttallii	.......AACAACCCTGCTTTCAAAGAAGTG.......GCGGTCCACATCTTATCTGAACTGCAATAATAACTGACTAAGCCGTGCCATAGCCACCGGAG	[443]
Phlox gracilis	GGGGGGCAAGAACCATGCTTTCAGAGAAGTG.......GCGGTCCAAATCTTATCTGAACTGCGAGAATAACTGACTAAGCCGTGCCATAGCCACCGGAG	[450]
Leptodactylon pungens	.......AAGAACCATGCTTTCAGAGAAGTG.......GCGGTCCAAATCTTATCTGAACTGCGAGAATAACTGACTAAGCCGTGCCATAGCCACCGGAG	[441]

Appendix 1. Continued.

	610 620 630 640 650 660 670 680 690 700	
Oenothera berteriana	......TCATTCTCCAAACGGGACGGGGCCAAGCCTTTAG.....GTTGTTTAAGTAGGTTGGGTGACAGATCGGCCATAGGAGTACTCCGGGATATAAA	[519]
Carpenteria californica	......GCATTCTCCAAACGGAACGGGGCCAAGCCTTTAG.....GTTGTTTAAGTAGGTTGGGTGACAGATCGGCCATAGGAGTACTCCGGGATATAAA	[520]
Astragalus equisolensis	......TCATTCTCCAAACGGGACGGGGTCAAGCCTTTAG.....ATTTTTTA.GTAGGTTGGGTGACAGATCGGCCATAGGAGTACTCCGGGATATAAA	[500]
Viburnum sieboldii	......TCATTCTCCAAACGGGACGGGGCCAAGCCTTTAG.....GTTGTTTAAGTAGGTTGGGTGACAGATCGGCCATAGGAGTACTCCGGGATATAAA	[516]
Pholisma arenaria	G.....TCATTCTCCAAACGGGACGGGGCCAAGCCTTTAG.....GTTGTTTAAGTAGGTTGGGTGACAGATCGGCCATAGGAGTACTCCGGGAGAGAAA	[511]
Petunia hybrida3704b	......TCATTCTCCAACGGGAACGGGGCCAAGCCTTTAG.....GTTGTTTAAGTAGGTTGGGTGACAGATCGGCCATAGGAGTACTCCGGGATATAAA	[506]
Hymenoxys richardsonii	......TCAT.CTCCAACGGGA.CG........CCTTTAG.....GTTGTTAAAGTAGGTTGGGTGACAGATCG.CCATAGGAGTACTCCGGGATATAAA	[497]
Hymenoxys hoopesii	......TCAT.CTCCAACGGGA.CG........CCTTTAG.....GTTGTTAAAGTAGGTTGGGTGACAGATCG.CCATAGGAGTACTCCGGGATATAAA	[497]
Dodecatheon clevelandii	......TCATTCTCCAAACGGGACGGGGCCAAGCCTTTAG.....GTT.TTTAAGTAGGTTGGGTGACAGATCGGCCATAGGATTACTCCGGGATATAAA	[505]
Anagallis arvensis	......TCCTTCTCCAAACGGGACGGGGCCAAGCCTTTAG.....GTT.TTTAAGTAGGTTGGGTGACAGATCGGCCATAGGATTACTCCGGGATATAAA	[505]
Ornithostaphylos oppositifolia	......GCATTCTCCAAACGGGACGGGGCCAAGCCTTTCGTTTAAGTTGTTTAAGTAGGTTGGGGGACAGATCGGCCATAGGAGTACTCCGGGGTATAAA	[525]
Styrax redivivus	......TCATTCTCCAAACGGGGCGGGGCCAATCCTTTAG.....GTTGTTTAAGTAGGTTGGGTGACAGATCGGCCATAGGAGTACTCCGGGATATAAA	[521]
Diapensia lapponica	......TCATTCTCCAAACGGGACGGGGCCAAACCTTTAT.....GTTGTTTAAGTAGGTTGGGTGACAGATCGGCCATAAGAGTACTCCGGGATATAAA	[509]
Fouqueria splendens	......TCATTCTCCAAACGGGACGGGGCCAAGCCTTTAG.....GTTGTTTAAGTAGGTTGGGTGACAGATCGGCCATAGGAGTACTCCGGGATATAAA	[510]
Bonplandia geminiflora	......TCATTCTCCAAACGGGACGGGGCCAAGCCTTTAG.....GTTGTTTAAGTAGGTTGGGTGACAGATCGGCCATAGGAGTACTCCGGGATATAAA	[529]
Cantua quercifolia	......TCATTCTCCAAACGGGACGGGGCCAAGCCTTTAG.....GTTGTTTAAGTAGGTTGGGTGACAGATCGGCCATAGGAGTACTCCGGGATATAAA	[522]
Cobaea scandens	......TAATTCTCCAAACGGGACGGGGCCAAGCCTTTAG.....GTTGTTTAAGTAGGTTGGGTGACAGATCGGCCATAGGAGTACTCCGGGATATAAA	[522]
Acanthogilia gloriosa	......TCATTCTCCAAACGGGACGGGGCCAAGCCTTTAG.....GTTGTTTAAGTAGGTTGGGTGACAGATCGGCCATAGGAGTACTCCGGGATATAAA	[522]
Polemonium formosissimum	......TCATTCTCCAAACGGGACGGGGCCAAGCCTTTAG.....GTTGTTTAAGTAGGTTGGGTGACAGATCGGCCATAGGAGTACTCCGGGATATAAA	[518]
Gilia splendens	GCTAAAGCATTCTCCAAACGGGACGGGGCCAAGCCTTTAG.....GTTGTTTAAGTAGGTTGGGTGACAGATCGGCCATAGGAGTACTCCGGGATATAAA	[671]
Collomia grandiflora	GCTAAAGCATTCTCCAAACGGGACGGGGCCAAGCCTTTAG.....GTTGTTTAAGTAGGTTGGGTGACAGATCGGCCATAGGAGTACTCCGGGATATAAA	[658]
Allophyllum gilioides	........ATTCTCCAAACGGGACGGGGCCAAGCCTTTAG.....GTTGTTTAAGTAGGTTGGGTGACAGATCGGCCATAGGAGTACTCCGGGATATAAA	[443]
Ipomopsis aggregata	GCTAAAGCATTCTCCAAACGGGACGGGGCCAAGCCTTTAG.....GTTGTTTAAGTAGGTTGGGTGACAGATCGGCCATAGGAGTACTCCGGGATATAAA	[533]
Loeselia glandulosa	GCTAAAGCATTCTCCAAACGGGACGGGGCCAAGCCTTTAG.....GTTGTTTAAGTAGGTTGGGTGACAGATCGGCCATAGGAGTACTCCGGGATATAAA	[533]
Aliciella micromeria	GCTAAAGCATTCTCCAAACGGGACGGGGCCAAGCCTTTAG.....GTTGTTTAAGTAGGTTGGGTGACAGATCGGCCGTAGGAGTACTCCGGGATATAAA	[533]
Aliciella subnuda	GCTAAAGCATTCTCCAAACGGGACGGGGCCAAGCCTTTAG.....GTTTTTTAAGTAGGTTGGGTGACAGATCGGCCGTAGGAGTACTCCGGGATATAAA	[533]
Aliciella mcvickerae	GCTAAAGCATTCTCCAAACGGGACGGGGCCAAGCCTTTAG.....GTTGTTTAAGTAGGTTGGGTGACAGATCGGCCGTAGGAGTACTCCGGGATATAAA	[533]
Aliciella latifolia	GCTAAAGCATTCTCCAAACGGGACGGGGCCAAGCCTTTAG.....GTTGTTTAAGTAGGTTGGGTGACAGATCGGCCGTAGGAGTACTCCGGGATATAAA	[533]
Gilia cf. scabra	GCTAAAGCATTCTCCAAACGGGACGGGGCCAAGCCTTTAG.....GTTGTTTAAGTAGGTTGGGTGACAGATCGGCCATAGGAGTACTCCGGGATATAAA	[533]
Linanthus nuttallii	GCTAAAGCATTCTCCAAGCAGGACGGGGCCAATCCTTTTT.....GTTGTTTAAGTTGGTGTGGTTACTTATCGGCCATAGGAGTCCTCCGGGATATAAA	[538]
Phlox gracilis	GCTAAAGCATTCTCCAAACGGGACGGGGCCAAGCCTTTAG.....GTTGTTTAAGTAGGTTGGGTGACAGATCGGCCATAGGAGTACTCCGGGATATAAA	[545]
Leptodactylon pungens	GCTAAAGCATTCTCCAAACGGGACGGGGCCAAGCCTTTAG.....GTTGTTTAAGTAGGTTGGGTGACAGATCGGCCATAGGAGTACTCCGGGATATAAA	[536]

Appendix 1. Continued.

	710 720 730 740 750 760 770 780 790 800	
Oenothera berteriana	..CAAGGGCAACAAATGTCGAGCATATGACGATGCCGCCCCTTTTCATTTCGTGGAAGCCCCCGGCAGAGGAAAGGGCTGTAGGTGATG.....GTGCGT	[612]
Carpenteria californica	..CCAGGGCAACAAATGTTGAGCATACGACGATGCCGCCCGTTTTCATTTCGTGGAAGTCCCCGGCAGAGGAAAGGGCTGTAGGTGATG.....GCGCGT	[613]
Astragalus equisolensis	..CCAGGGCAACCAATGTCGAGCATACGACGATGCCGCCCGTTTTCATTTCGTGGAAGTCCCCGGCAGAGGAAAGGGCTGTAGGTGATG.....GCGCGT	[593]
Viburnum sieboldii	..CCAGGGCAACAAAAGTAGAGCATACGACGATGCCGCCCGTTTTCATTTCGTGGAAGTCCCCGGCAGAGGAAAGGGCTGTAGGTGATG.....GCGCGT	[609]
Pholisma arenaria	AACCAGGGCAACTAAAG.........CGACGATGCCGCCCATTTTCATTTCGTGGAAGTCCCCGGCAGAGGAAAGGGCTGTAGGTGATG.....GCGCGT	[597]
Petunia hybrida3704b	..CCAGGGCAACAAAAGTGGAGCATACGACGATGCCGCCCGTTTTCATTTCGTGGAAGTGCCCGGCAGAGGAAAGGGCTGTAGGTGATG.....GCGCGT	[599]
Hymenoxys richardsonii	..CCAGGGCAACAAAAGTGGAGCATACGGCGATCCCGCCCGTTTTCATTTCGTGGAAGTCCCCGGCAGAGGAAAGGGCTGTAGGTGATG.....GCGCGT	[590]
Hymenoxys hoopesii	..CCAGGGCAACAAAAGTGGAGCATACGGCGATCCCGCCCGTTTTCATTTCGTGGAAGTCCCCGGCAGAGGAAAGGGCTGTAGGTGATG.....GCGCGT	[590]
Dodecatheon clevelandii	..AAAGGGCAACCCATGTTGAGCATACGACGATGCCGCCCGTTTTCATTTCGTGGAAGTCCCCGGCAGAGGAAAGGGCTGTTTGTGATG.....GCGCGT	[598]
Anagallis arvensis	..CAAGGGCAACCCATGTTGAGCATACGACGATGCCGCCCGTTTTCATTTCGTGGAAGTCTCCGGCAGAAGAAAGGGCTGTTTGTGATG.....GCGCCT	[598]
Ornithostaphylos oppositifolia	..CCAGGGCAACCAATGTTGAGCATACGACGATGCCGCCCGTTTTCATTTCGTGGAAGTCCCCGGCAGAGGAAAGGGCTGTATGTGATG.....GCGCGT	[618]
Styrax redivivus	..CCAGGGCAAAAAATGTTGAGCATACGACGATGCCGCCCGTTTTAATTTCGTGGAAGTCCCCGGCAGAGGAAAGGGCTGTATGTGATGTGATGGCGCGT	[619]
Diapensia lapponica	..CCAGGGCAACAAATGTTGAGCATACCACAATGCCGCCTGTTTTCATTTCATGTAAGTCCCCGGCAGAAGAAAGGGCTGTATGTGATT.....GCGCGT	[602]
Fouqueria splendens	..CCAGGGCAACAAATGTTGAGCATACGACGATGCCGCCCGTTTTCATTTCGTGGAAGTCCCCGGCAGAGGAAAGGGCTGTAGGTGATG.....GCGCGT	[603]
Bonplandia geminiflora	..CCGGGGCAACAAATGTTGAGCATACGACGATGCCGCCCGCCTTCATTTCGTGGAAGTCCCCGGCAGAGGAAAGGGCTATAGGTGATG.....GCGCGT	[622]
Cantua quercifolia	..CCGGGGCAACAAATGTTGAGCATACGACGATGCCGCCCGCCTTCATTTCGTGGAAGTCCCCGGCAGAGGAAAGGGCTGTAGGTGATG.....GCGCGT	[615]
Cobaea scandens	..CCGGGGCAACAAATGTTGAGCATACGACGATGCCGCCCGCCTTCATTTCGTGGAAGTCCCCGGCAGAGGAAAGGGCTGTAGGTGATG.....GCGCGT	[615]
Acanthogilia gloriosa	..CCGGGGCAACAAATGTTGAGCATACGACGATGCCGCCCGCTTTCATTTCGTGGAAGTCCCCGGCAGAGGAAAGGGCTGTAGGTGATG.....GCGCGT	[615]
Polemonium formosissimum	..CCGGGGCAACAAATGTTGAGCATACGACGATGCCGCCCGCTTTCATTTCGTGGAAGTCCCCGGCAGAGGAAAGGGCTGTAGGTGATG.....GCGCGT	[611]
Gilia splendens	..CCGGGGCAACAAATGTTGAGCATACGACGATGCCGCCCGCTTTCATTTCGTGGAAGTCCCCGGCAGAGGAAAGGGCTGTAGGTGATG.....GCGCGT	[764]
Collomia grandiflora	..CCGGGGCAACAAATGTTGAGCATACGACGATGCCGCCCGCTTTCATTTCGTGGAAGTCCCCGG.AGAGGAAAGGGCTGTAGGTGATG.....GCGCGT	[750]
Allophyllum gilioides	..CCGGGGCAACAAATGTTGAGCATACGACGATGCCGCCCGCTTTCATTTCGTGGAAGTCCCCGGCAGAGGAAAGGGCTGTAGGTGATG.....GCGCGT	[536]
Ipomopsis aggregata	..CCGGGGCAACAAATGTTGAGCATACGACGATGCCGCCCGCTTTCATTTCGTGGAAGTCCCCGGCAGAGGAAAGGGCTGTAGGTGATG.....GCGCGT	[626]
Loeselia glandulosa	..CCGGGGCAACAAATGTTGAGCATACGACGATGCCGCCCGCTTTCATTTCGTGGAAGTCCCCGGAAGAGGAAAGGGCTGTAGGTGATG.....GCGCGT	[626]
Aliciella micromeria	..CCGGGGCAACAAATGTTGAGCATACGACGATGCCGCCCGCTTTCATTTCGTGGAAGTCCCCGGCAGAGGAAAGGGCTGTAGGTGATG.....GCGCGT	[626]
Aliciella subnuda	..CCGGGGCAACAAATGTTGAGCATACGACGATGCCGCCCGCTTTCATTTCGTGGAAGTCCCCGGCAGAGGAAAGGGCTGTAGGTGATG.....GCGCGT	[626]
Aliciella mcvickerae	..CCGGGGCAACAAATGTTGAGCATACGACGATGCCGCCCGCTTTCATTTCGTGGAAGTCCCCGGCAGAGGAAAGGGCTGTAGGTGATG.....GCGCGT	[626]
Aliciella latifolia	..CCGGGGCAACAAATGTTGAGCATACGACGATGCCGCCCGCTTTCATTTCGTGGAAGTCCCCGGCAGAGGAAAGGGCTGTAGGTGATG.....GCGCGT	[626]
Gilia cf. scabra	..CCGGGGCAACAAATGTTGAGCATACGACGATGCCGCCCGCTTTCATTTCGTGGAAGTCCCCGGCAGAGGAAAGGGCTGTAGGTGATG.....GCGCGT	[626]
Linanthus nuttallii	..CCGGGGCAACAATTGTTCAGCATACGACGATGCCGCCCGCTTTCATTTCGTGGAACTCCCCGGAAGAAGAAAGG.CTGTAGGTGATG.....GCGCGT	[630]
Phlox gracilis	..CCGGGGCAACAAATGTTGAGCATACGACGATGCCGCCCGCTTTCATTTCGTGGAAGTCCCCGGCAGAGGAAAGGGCTATAGGTGATG.....GCGCGT	[638]
Leptodactylon pungens	..CCGGGGCAACAAATGTTGAGCATACGACGATGCCGCCCGCTTTCATTTCGTGGAAGTCCCCGGCAGAGGAAAGGGCTATAGGTGATG.....GCGCGT	[629]

Appendix 1. Continued.

	810 820 830 840 850 860 870 880 890 900	
Oenothera berteriana	TCTGCTTCTTATCTAGCGTTAGAGGGGCGCTGAAATCGTTCCTATTGGGTCGTGCGTGGCAGCTGGTATAGATGAATA.AAGGC..GGGCCGCTTGAACG	[709]
Carpenteria californica	TCTGCTTCTTATCTAG....AGAGGGGCGCTGAAATCGTTCCTATTGGGTCGTGCGTGGCAGCTGGTATAGATGAATA.AAGGC..GGCCCGCTTGAACG	[706]
Astragalus equisolensis	TCTGCTTCTTATCTAG....ATAGGGGC.......TCGTTCCTATTGGGTCGTGCGTGGCAGCTGGTATAGATGAATA.AAGGCGCGGCCCGCTTGAACG	[681]
Viburnum sieboldii	TCTGCTTCTTATCTAG....AGAGGGGCGCTGAAATCCTTTCTATTGGGTCGTGCGTGGCAGCTGGTATAGATGAATA.AAGGC..GGACCGCTTGAACG	[702]
Pholisma arenaria	TCTGCTTCAACTCTAG....AGAGGGGCGCTGAAATCCTTTCTATTGGTTCGTGCGTGGCATCTGGTATAGATGAAGAAAAGGC..GG.CCGCTTTTTCG	[690]
Petunia hybrida3704b	TCTGCTTCTTATCTAG....AGAGGGGCGTCGAAATCCTTTCTATTGGTTCTTGCGTGGCAGCTGGTATAGATGATGA.AAGGC..GGGCCGCTTTTTCG	[692]
Hymenoxys richardsonii	TCTGCTTCTTATCTAG....AGAGGGGCGCTGAAATCCTTTCTATGGGCTCGTGCGTGGCAGCTGGTATAGATGAAGA.AAGGC..GGACCGCTTGAACG	[683]
Hymenoxys hoopesii	TCTGCTTCTTATCTAG....AGAGGGGCGCTGAAATCCTTTCTATGGGCTCGTGCGTGGCAGCTGGTATAGATGAAGA.AAGGC..GGACCGCTTGAACG	[683]
Dodecatheon clevelandii	TTTGCTTCTTATCTAG....AGAGGGGCGCTGAAATCGTTCCTATTTGGTCGTGCGTGGCAGCTGGTATAGATGAATA.TAGGC..GGGCCGCTTTAACT	[691]
Anagallis arvensis	TTTGCTTCTTATCTAG....CGAGGGGCGCTGAAATCGTTCCTATTGGGTCCTGCGTGGCAGCTGGTATAGATGAAGA.AAGGC..GGGCCACTTTAACG	[691]
Ornithostaphylos oppositifolia	TTTGCTTCTTATCGTT....AGAGGGGCGCTGAAATCGGTCCTATTGGGTCGTGCGTGGCAGCTGGTATAGATGAATA.AAGGC..GGGCCGCTTGAACG	[711]
Styrax redivivus	TTTGCTTCTTATCTAG....AGAGGGGCGCTGAAATCGTTCCTATTGGGTCGTGCGTGGCAGCTGGTATAGATGAAGA.AAGGC..GGGCCGCTTGAACG	[712]
Diapensia lapponica	TTTGCTTCTTATCGTG....ATAGGGGCGCTGAAAGCTTTTCTATTGGGTCTTGCG....GGCTGGTATAGATGAATA.AAGGC..GGGCCGCTTGAACG	[691]
Fouqueria splendens	TTTGCTTCTTATCTAG....AGAGGGGCGCTGAAATCGTTCCTATTGGGTCGTGCGTGGCAGCTGGTATAGATGAATA.AAGGC..GGGCCGCTTGAACG	[696]
Bonplandia geminiflora	TTTGCTTCTTATCTAG....AGAGGGGCGCTGAAATCGCTCCCATTGGGTCGTGCGTGGCAGCTGGTATAGATGAATA.AAGGC..TATA.GCTTGAACG	[714]
Cantua quercifolia	TTTGCTTCTTATCTAG....AGAGGGGCGCTGAAATCGTTCCTATTGGGTCGTGCGTGGCAGCTGGTATAGATGAATA.AAGGC..GGGCCGCTTGAACG	[708]
Cobaea scandens	TTTGCTTCTTATCTAG....AGAGGGGCGCTGAAATCGTTCCTATTGGGTCGTGCGTGGCAGCTGGTATAGATGAATA.AAGGC..GTG.......AACG	[701]
Acanthogilia gloriosa	TTTGCTTCTTATCTAG....AGAGGGGCGCTGAAATCGTTCCTATTGGGTCATGCGTGGCAGCTGGTATAGATGAATA.AAGGC..GGGCCGCTTGAACG	[708]
Polemonium formosissimum	TTTGCTTCTTATCTAG....AGAGGGGCGCTGAAATCGTTCCTATTGGGCCGTGCGTGGCAGCTGGTATAGATGAATA.AAGGC..GGGCCGCTTGAACG	[704]
Gilia splendens	TTTGCTTCTTATCTAG....AGAGGGGCGCTGAAATCGTTCCTATTGGGCCGTGCGTGGCAGCTGGTATAGATGAATA.AAGGC..GGG...........	[846]
Collomia grandiflora	TCTGCTTCTTATCTAG....AGAGGGGCGCTGAAATCGTTCCTATTGGGCCGTGCGTGGCAGCTGGTATAGATGATTA.AAGGC..GGGCCGCTTGGACG	[843]
Allophyllum gilioides	TTTGCTTCTTATCTAG....AGAGGGGCGCTGAAATCGTTCCTATTGGGCCGTGCGTGGCAGCTGGTATAGATGAATA.AAGGC..GGGCCGCTTGAACG	[629]
Ipomopsis aggregata	TTTGCTTCTTATCTAG....AGAGGGGCGCGGAAATCGTTCCTATTGGGCCGTGCGTGGCAGCTGGTATAGATGAATA.AAGGC..GGGCCGCTTGAACG	[719]
Loeselia glandulosa	TTTGCTTCTTATCTAG....AGAGGGGCGCGGAAATCGTTCCTATTGGGCCGTGCGTGGCAGCTGGTATAGATGAATA.AAGGC..GGGCCGCTTGAACG	[719]
Aliciella micromeria	TTTGCTTCTTATCTAG....AGAGGGGCGCTGAAATCGTTCCTATTGGGCCGTGCGTGGCAGCTGGTATAGATGAATA.AAGGC..GGGCCGCTTGAACG	[719]
Aliciella subnuda	TTTGCTTCTTATCTAG....AGAGGGGCGCTGAAATCGCTCCTATTGGGCCGTGCGTGGCAGCTGGTATAGATGAATA.AAGGC..GGGCCGCTTGAACG	[719]
Aliciella mcvickerae	TTTGCTTCTTATCTAG....AGAGGGGCGCTGAAATCGTTCCTATTGGGCCGTGCGTGGCAGCTGGTATAGATGAATA.AAGGC..GGGCCGCTTGAACG	[719]
Aliciella latifolia	TTTGCTTCTTATCTAG....AGAGGGGCGCTGAAATCGTTCCTATTGGGCCGTGCGTGGCAGCTGGTATAGATGAATA.AAGGC..GGGCCGCTTGAACG	[719]
Gilia cf. scabra	TTTGCTTCTTATCTAG....AGAGGGGCGCTGAAATCGTTCCTATTGGGCCGTGCGTGGCAGCTGGTATAGATGAAAA.AAGGC..GGGCCGCTTGAACG	[719]
Linanthus nuttallii	TTTGCTTCTTATCTAG....AGAGGGGCGCTGAAATCGTTCCTATTGGGCCGTGCGTGGCAGCTGGTATAGATGAATA.AAGGC..GGGCCGCTTGAACG	[723]
Phlox gracilis	TTTGCTTCTTATCTAG....AGAGGGGCGCGGAAATCGTTCCTATTGGGCCGTGCGTGGCAGCTGGTATAGATGAATA.AAGGC..GGGCCGCTTGAACG	[731]
Leptodactylon pungens	TTTGCTTCTTATCTAG....AGAGGGGCGCTGAAATAGTTCCTATTGGGCCGTGCGTGGCAGCTGGTATAGATGAATA.AAGGC..GGGCCGCTTGAACG	[722]

Appendix 1. Continued.

	910 920 930 940 950 960 970 980 990 1000	
Oenothera berteriana	.....GGACCTATTCTCAACATAG............GCGGCAAGGCTGAATA....GGAAAGGGGCCGAGCTGACTGATGAGAGCCTTTTTAGCTTAGCC	[788]
Carpenteria californica	.....GGACCTATTCTCTTAATAG............GCGGCAAAGCT?????....??????????????????CTGATGAGTGCCTTTT.........G	[753]
Astragalus equisolensis	.....GGACCTATTCTCTTAATAG............GCGGCAAAGCTGAATA....GGAAAGGGGCCGAGCTGACTGATGAGT............TTTTA	[748]
Viburnum sieboldii	.....GGACCTATTCTCTTAATAG............GCGGCAAAGCGGAATA....GGAAAGGGGCCGAGCTGACTGATGAGTGCCTTTTTA........	[773]
Pholisma arenaria	.....GGACCTATTCTCTTCATAG............GGGGCAAAGCGAAATA....GGAAAGGGGCCGA.CTGACTGATGAGT.CCTTTTTA........	[759]
Petunia hybrida3704b	.....GGACCTATTCTCTTAATAG............GCGGCAAAGCGAAATA....GGAAAGGGGCCGAGCTGACTGATGAGTGCCTTTTTA........	[763]
Hymenoxys richardsonii	.....GGACCTATTCTCTTAATAG............GCGGCAAAGCGGAATA....G...	[719]
Hymenoxys hoopesii	.....GGACCTATTCTCTTAATAG............GCGGCAAAGCGGAATA....G...	[719]
Dodecatheon clevelandii	GGATCGGACCTATTCTCTTAATAG............GCGGCAAAGCAGAATA....AGAAAGGGACG.ACCTGACTGATGAGTGCCTCTTTTC......C	[768]
Anagallis arvensis	TAAGGGGACCTATTCTCTTAATAG............GCGGCAAAGCTGAATA....AGAAAGGGACG.ACCTGACTGATGAGTGCCTCTTTTG......A	[768]
Ornithostaphylos oppositifolia	.....GGACCTATTCTCTTAATAG............GCGGCAAAGCGGCATA....GGAAAGGGACCGAGCTGACTGATGAGTGCCTTTTT.......AA	[783]
Styrax redivivus	.....GGACCTATTCTCTTAATAGTTCTTTAAATAGGCGGCAAAGCGGAATA....GGAAAGGGACCGAGCTGACTGATAAGTGACTTTTT........A	[795]
Diapensia lapponica	.....GGACCTGTTATCTTAATAG............GTGGAAAAGCGGAATA....GGAAAGGGACCGAGCTGACTGATGAGTTCCTTTTT........A	[762]
Fouqueria splendens	.....GGACCTATTCTCTTAATAG............GGGGGAAAGCGGGATA....GGAAAGGGACG.AGCTGACTGATGAGTGCCTTCTTTTTT.....	[769]
Bonplandia geminiflora	.....GGACCTATTCTCTTAATAG............GGGACAAAGCGGAATA....GGAAAGGGACG.AGCTGACTGATGAGTGCCTTTT.ATTATATTA	[791]
Cantua quercifolia	.....GGACCTATTCTCTTAATAG............GCGACAAAGCGGAATA....GGAAAGGGACCGAGCTGACTGATGAGTGCCTTTTTATGATATTA	[787]
Cobaea scandens	.....GGACCTATTCTCTTAATAG............GCGACAAAGCGGAATA....GGAAAGGGAC.GAGCTGACTGATGAGTGCCTTTTTATTATATTA	[779]
Acanthogilia gloriosa	.....GGACCTATTCTCTTAATAG............GCGACAAAGCGGAATA....GGAAAGGGACCGACCTGACTGATGAGTGCCTTATTATTAGATTA	[787]
Polemonium formosissimum	.....GGACCTATTCTCTTAATAG............GCGACAAAGCGGAATA....GGAAAGGGACG.AGCTGACTGATGAGTGCCTTTTTATTAG....	[778]
Gilia splendens	....	[846]
Collomia grandiflora	.....GCACCTATTCTTCTAATAG............GCGACAAAGCGGAATA....GGAAAGGGACG.AGCTGACTGATGAGTGCCTTTTTATTAGATTA	[921]
Allophyllum gilioides	.....GGACCTATTCTCTTAATAG............GCGACAAAGCGGAATA....GGAAAGGGACG.AGCTGACTGATGAGTGCCTTTTTATTAGATTA	[707]
Ipomopsis aggregata	.....GGACCTATTCTCTTAATAG............GCGACAAAGCGGAATA....GGAAAGGGACG.AGCTGACTGATGAGTGCCTCTTTATTAGATTA	[797]
Loeselia glandulosa	.....GGACCTATTCTCTTAATAG............GTGACAAAGCGGAATA....GGAAAGGGACCGAGCTGACTGATGAGTGCCTTTTTATTAGATTA	[798]
Aliciella micromeria	.....GGAACTATTCTCTTAATAG............GCGACAAAGCGGAATA....GGAAAGGGACCGAGCTTACTGATGAGTGCCTTTTTATTAGATTA	[798]
Aliciella subnuda	.....GGACCTATTCTCTTAATAG............GCGACAAAGCGGAATA....GGAAAGGGAC.GAGCTTACTGATGAGTGCCTTTTTATTAGATTA	[797]
Aliciella mcvickerae	.....GGACCTATTCTCTTAATAG............GCGACAAAGCGGAATA....GGAAAGGGACG.AGCTTACTGATGAGTGCCTCTTTATTAGATTA	[797]
Aliciella latifolia	.....GGACCTATTCTCTTAATAG............GCGACAAAGCGGAATA....GGAAAGGGACG.AGCTCACTGATGAGTGCCTCTT.ATTAGATTA	[796]
Gilia cf. scabra	.....GGACCTATTCTCTTAATAG............GCGACAAAGCGGAATA....GGAAAGGGACCGAGCTGACTGATGAGTGCCTTTTTATTAGATTA	[798]
Linanthus nuttallii	.....GGACCTATTCTCTTAATAG............GCGACAAAGCGGAATA....GGAAAGGGACCGAGCTGACTGATGAGTGCCTTTTTATTAGATTA	[802]
Phlox gracilis	.....GGACCTATTCTCTTAATAG............GCGACAAAGCGGAATA....GGAAAGGGACGA????????????????????????????????	[768]
Leptodactylon pungens	.....GGACCTATTCTCTTAATAG............GCGACAAAGCGGAATA....??	[771]

Appendix 1. Continued.

	1010 1020 1030 1040 1050 1060 1070 1080 1090 1100	
Oenothera berteriana	TTTTTCTAACTAAAGGCTCTC..ATGTGGAGCTAGGCTGGCT....ACATACAAGTATAGCCAAATCAAGATGAGACGGGGCGGACGG..TCAGA.....	[875]
Carpenteria californica	ACCTTAGAAAAAAAAACGCTCTCATGTGGAGCTAACATGGCTGGCTACATACAAGTATAGCCAAATCAAGATGAGACGGGACAGACGG..TCAGA.....	[873]
Astragalus equisolensis	GCCTTAAAAAAAAGGGCTCTCTCATGTGAAGCTAACATGGCTGGCTACATACAAGTATAGCCAAATCAAGATGAGACGTAACGGACGG..TCAGA.....	[841]
Viburnum sieboldii	GCCTTTTTCT...AAAGGCTCTCATGTGGAGCTAACATGGCTGGCTACATACAAGTATAGCCAAATCCAGATGAGACGGGACGGACGG..TCAGA.....	[863]
Pholisma arenaria	GCCTTTTTCT...AAAGGCACTCATGTGGGGC.........AGGCCCCCAAAAAGTAAAAAAAAAAA..GATGAGACGGGACGGACGG..TCAGA.....	[838]
Petunia hybrida3704b	GCCTTTATTTT..AAAGGCTCTCATGTGGAGCTAACATGGCTGGTTACATACAAGTATAGCCAAATCAAGATGAGATGGGACGGCCGT..TCAGA.....	[854]
Hymenoxys richardsonii	....	[719]
Hymenoxys hoopesii	....	[719]
Dodecatheon clevelandii	GCCTTTATAAAAA...GGCTCTCATGTGGAGCTAACATGGCTGGCTCCATACAAGTATATCCAAATCAAGATGAGACGGGACGGACGG..TCCAA.....	[858]
Anagallis arvensis	GCCTTTAGAAAAA...GGCTCTCATGTGGAGCTAACATGGCTGGCTCCATACAAGTATATCCAAATCAAGATGAGACGGGACGGACGG..GCCAA.....	[858]
Ornithostaphylos oppositifolia	TTAAATTAAAAAA...GGCTCTCATGTGGAGCTAACATGGCTGGCTACATACAAGTATAGCCAAATCAAGATGAGACGGGACGGACGG..TCAGA.....	[873]
Styrax redivivus	GCCTTTTTCTAAA...GGCTCTCATGTGGAGCTAACATGGCTGGCTACATACAAGTATAGCCAAATCAAGATGAGACGGGACGGACGG..TCAGA.....	[885]
Diapensia lapponica	GCCTTTAGAAAAA...GGCTCTCATGTGGAGCTAACATGGCTGGCTACATACAAGTATAGCCAAATCAAGATGAGACGGGACGGACGG..TCAGA.....	[852]
Fouqueria splendens	.CCTT........AAAGGCTCTCATGTGGAGCTAACATGGCTGGCTACATACAAGTATAGCCAAATCAAGATGAGACGGGACGGTCGG..TCAGA.....	[853]
Bonplandia geminiflora	GCCTCTAGGAAAAAAAGGCTCTCATGTGGAGCTAACATGGTTGGCTACATGCAAGTATAGCCAAATCAAGATGAGACGGGGCCTTTAAAAAGTGGTTCAA	[891]
Cantua quercifolia	GCCTTTAGGAAAAAAAGGCTCTCATGTGGAGCTAACATGGCTGGCTACATGCAAGTATAGCCAAA....GATGAGACGGGACGGACGG..TCAGA.....	[876]
Cobaea scandens	GCCTCTAGGAAAAAAAGGCTCTCATGTGGAGCTAACATGCTTGGCTACATGCAAGTATAGCCAAATCAAGATGAGACGGGACGGTCGG..TCAGA.....	[872]
Acanthogilia gloriosa	GCCTTTAGAAAAAAAAGGCTCTCATGTGGAGCTAACATGGCTGGCTACATGCAATTATAGCCAAATCAAGATGAGACGGGACGGACGG..TCCGA.....	[880]
Polemonium formosissimum	.CCTTTAGAAAAAAAAGGCTCTCATGTGGAGCTAACATGGCTGGCTACATGCAAGTATAGCCAAATCAAGATGAGACGGGACGGACGG..TCAGA.....	[870]
Gilia splendens	....	[846]
Collomia grandiflora	GCCTTTAGAAAA.AAAGGCTCTCATGTGGAGCTAACATGGCTGGCTACATGCAAGTATAGCCAAATCAAGATGAGACGGGACGGACGG..TAAGA.....	[1013]
Allophyllum gilioides	GCCTTTAGAAAAAAAAGGCTCTCATGTGGAGCTAACATGGCTGGCTACATGCAAGTATAGCCAAATCAAGATGAGACGGGACGGACGG..TAAGA.....	[800]
Ipomopsis aggregata	GCCTTTAGAAAAAAAAGGCTCTCATGTGGAGCTAACATGGCTGGCTACATGCAAGTATAGCCAAATCAAGATGAGACGGGACGGACGG..TCAGA.....	[890]
Loeselia glandulosa	G......AAAAAAAAAGGCTCTCATGTGGAGCTAACATGGCTGGCTACATGCAAGTATAGCCAAATCAAGATGAAACGGGACGGACGG..TCAAA.....	[885]
Aliciella micromeria	GCCTTTAGAAAAAAAAGGCTCTCATGTGGAGCTAACATGGCTGGCTACATGCAAGTATAGCCAAATCAAGATGAGACGGGACGGACGG..TCAGA.....	[891]
Aliciella subnuda	GCCTTTAGAAAAAAAAGGCTCTCATGTGGAGCTAACATGGCTGGCTACATGCAAGTATAGCCAAATCAAGATGAGACGGGACGGACGGAACTACA.....	[892]
Aliciella mcvickerae	GCCTTTAGAAAAAAAAGGCTCTCATGTGGAGCTAACATGGTTGGCTACATGCAAGTATAGCCAAATCAAGATGAGACGGGACGGACGG..TCAGA.....	[890]
Aliciella latifolia	GCCTTTAGAAAAAAAAGGCTCTCATGTGGAGCTAACATGGCTGGCTACATGCAAGTATAGCCAAATCAAGATGAGACGGGACGGACGG..TCAGA.....	[889]
Gilia cf. scabra	GCCTTTAGAAAAAAAAGGCTCTCATGTGGAGCTAACATGGCTGGCTACATGCAAGTATAGCTAAATCAAGATGAGACGGGACGGACGG..TCAGA.....	[891]
Linanthus nuttallii	GCCTTTAGAAAAAAAAGGC...	[821]
Phlox gracilis	???.....	[768]
Leptodactylon pungens	???CGGACGG..TAAGA.....	[783]

Appendix 1. Continued.

	1110 1120 1130 1140 1150 1160 1170 1180 1190 1200	
Oenothera berteriana	...................GGCCGCAGCGGGACTACCATAGGAAA.GCGCGCCCCCGCTAGCTAACATAGAAAGAGATTCCCGTAACGCATCCGTCTCTA	[955]
Carpenteria californica	....	[846]
Astragalus equisolensis	...................AGCCGCAGCGGGACTCTCATAGGAAA.GCCC..	[871]
Viburnum sieboldii	...................GGCCGCAGCGGGACTACCATAGGAAA.GCCCGCCCCCGCTAGCTAACATAGAAATCTATTCCCGGAAAGTCAGAGTCTCTA	[943]
Pholisma arenaria	....................GCCGCTGCGGGGCTACCATAGGAAA.GCCCGCCCCC..	[874]
Petunia hybrida3704b	...................GGCCGCAGCGGGACTACCATTGGAAA.GCTCGCCCC...	[890]
Hymenoxys richardsonii	....	[719]
Hymenoxys hoopesii	....	[719]
Dodecatheon clevelandii	...................GGCCGCAGCGGGAATACCATAGGAAA.GCCCGCCCCCCCTAGCTAACATAGAAATGGATTCCCGGATAGCAGTAGTCTCTA	[938]
Anagallis arvensis	...................GGCCGCACCGGGAATACCATAGGAAA.GCCCGCCCC..TAGCTAACATAGAAATGGATTCCCGGATAGCAGTAGTCTCTA	[936]
Ornithostaphylos oppositifolia	...................GGCCGCAGCGGGACTACCATAGGAAA.GCCCGCCCCCGCTAGCTAACATAGAAATAGATTCCCGGATAGCAGTAGTCTCTA	[953]
Styrax redivivus	...................GGCCGCAGCGGGACTACCATAGGAAAA.CCCGCCCCCGCTAGCTAACATAGAAATGGATTCCCGGATAGCAGTAGTCTCTA	[965]
Diapensia lapponica	...................CGCCGCAGCGGGACTACCATAGGAAA.GCCCGCCCCCGCTAGCTAACGTAGACATTTTTTCCCGGATAGCAGT.....CTA	[927]
Fouqueria splendens	...................GGCCGCAGCGGGACTACCATAGGAAA.GCCCGACCCCGCTAGCTAACATAGAAATTGATTCCCGGATAGCAGTAGTCTCTA	[933]
Bonplandia geminiflora	GCTATAACCTTTATTCATCGGCCGCAGCGGGACTACCATAGGAAAAGCCCGCCCCCGCTAGCTAACATAGAAATGGATTCCCGGATAGCAGTAGTCTCTA	[991]
Cantua quercifolia	...................GGCCGCAGCGGGACTACCATAGGAAA.GCCCGCCCCCGCTAGCTAACATAGAAATGGATTCCCGGATAGCAGTAGTCTCTA	[956]
Cobaea scandens	....................GCCGCAGCGGGACTACCATAGGAAA.GCCCGCCCCCGCTAGCTAACATAGAAATGGATTCCCGGATAGCAGTAGTCTCTA	[951]
Acanthogilia gloriosa	...................GGCCCCAGCGGGACTACCATAGGAAA.GCCCGCCCCCGCTAGCTAACATAGAAATGGATTCCCGGATAGCAGTAGTCTCTA	[960]
Polemonium formosissimum	...................GGCCGCAGCGGGACTACCATAGGAAAAGCCCGCCCCCGCTAGCTAACATAGAAATGGATTCCCGGATAGCAGTAGTCTCTA	[951]
Gilia splendens	....	[846]
Collomia grandiflora	...................GGCCGCAGCGGGACTACCATAGGAAA.GCCCGCCCCCGCTAGCTAACATAGAAATGGATTCCCGGATAGCAGTAGTCTCTA	[1093]
Allophyllum gilioides	...................GGCCACAGCGGGACTACCATAGGAAAAGCCCGCCCCCGCTAGCTAACATAGAAATGGATTCCCGGATAGCAGTAGTCTCTA	[881]
Ipomopsis aggregata	...................GGCCGCAGCGGGACTACCATAGGAAA.GCCCGCCCCCGCTAGCTAACATAGAAATGGATTCCCGGATAGCAGTAGTCTCTA	[970]
Loeselia glandulosa	...................GGCCGCAGCGGGACTACCATAGGAAA.GCCCACCCCCGCTAGCTAACATAGAAATGGATTCCCGGATAGCAGTAGTCTCTA	[965]
Aliciella micromeria	...................GGCCGCAGCGGGACTACCATAGGAAA.GCCCGCCCCCGCTAGCTAACATAGAAATGGATTCCCGGATAGCAGTAGTCTCTA	[971]
Aliciella subnuda	..................TTGCCGCAGCGGGACTACCATAGGAAA.GCCCGCCCCCGCTAGCTAACATAGAAATGGATTCCCGGATAGCAGTAGTCTCTA	[973]
Aliciella mcvickerae	...................GGCCGCAGCGGGACTACCATAGGAAA.GCCCGCCCCCGCTAGCTAACATAGAAATGGATTCCCGGATAGCAGTAGTCTCTA	[970]
Aliciella latifolia	...................GGCCGCAGCGGGACTACCATAGGAAA.GCCCGCCCCCGCTAGCTAACATAGAAATGGATTCCCGGATAGCAGTAGTCTCTA	[969]
Gilia cf. scabra	....................GCCGCAGCGGGACTACCATAGGAAA.GCCCGCCCCCGCTAGCTAACATAGAAATGGATTCCCGGATAGCAGTAGTCTCTA	[970]
Linanthus nuttallii	....CCCGCTAGGGAACATAGAAATGGTTTCCTGGATAGCAGTAGTGTCTA	[868]
Phlox gracilis	...................GGCCGCAGCGGGACTACCATAGGAAAAGCCCGCCCCCGCTAGCTAACATAGAAATGGATTCCCGGATAGCAGTAGTCTCTA	[894]
Leptodactylon pungens	...................GGCCGCAGCGGGACTACCATAGGAAAAGCCCGCCCCCGCTAGCTAACATAGAAATGGATTCCCGGATAGCAGTAGTCTCTA	[864]

Appendix 1. Continued.

	1210 1220 1230 1240 1250 1260 1270 1280 1290 1300	
Oenothera berteriana	TGTGAATCTCTTCCCGACCAGGCCAGGCCGAATCGGGCCACCACTTGGGATGGGAATGGCTCAGCCC.ACATGCATCATTTGATGAAAGCACTCC..AGT	[1052]
Carpenteria californica	.........................GGCCAAATCGGGCCACCACTTGGGATGGGAATGGCTCAGCCC.ACATGCATCGTTTGATGAAAGCACTCC..AGT	[918]
Astragalus equisolensis	....	[871]
Viburnum sieboldii	TGTGAATCTCTTCCCGACCGGGCCAGGCCGAATC.GGCCACCACTTGGGATGGGAATGGCTCAGCCCCACATGCATCATTTGATGAAAGCACTCC..AGT	[1040]
Pholisma arenaria	....	[874]
Petunia hybrida3704b	....	[890]
Hymenoxys richardsonii	....	[719]
Hymenoxys hoopesii	....	[719]
Dodecatheon clevelandii	TGTGAATCTCTTCCCGACCGGGCCAGGCCGAATCGGGCCACCACTTGGGATGGGAATGGCTCAGCCC.ACATGCATCATTTGATGAAAGCACTTC..AGC	[1035]
Anagallis arvensis	TGTGAATCTCTTCCCGACCGGGCCAGGCCGAATCGGGCCACCACTTGGGATGGGAATGGCTCAGCCC.ACATGCATCATTTGATGAAAGCACTTC..AGC	[1033]
Ornithostaphylos oppositifolia	TGTGAATCTCTTCCCGACCGGGCCAGGCCGAATTGGGCCACCACTTGGGATGGGAATGGCTCAGCCC.ACATCCATCATTTGATGAAAGCACTCC..AGC	[1050]
Styrax redivivus	TGTGAATCTCTTCCCGACCGGGCCAGGCCGAATCGGGCCACCACTTGGGATGGGAATGGTTCAGCCC.ACATGCATCATTTGATGAAAGCACTCC..AGC	[1062]
Diapensia lapponica	TGTGAATCTCTTCCCGACCGGGCCAGGCCGAATCGGGCCACCACTTGGGATCGGAATGGTTCAGTCT.ACATGCATCATTTGATGAAAGCACTCC..AGC	[1024]
Fouqueria splendens	TGTGAATCTCTTCCCGACCGGGCCAGGCCGAATCGGGCCACTACTTGGGATGGGAATGGCTCAGCCC.ACATGCATCATTTGATGAAAGCACTCC..AGC	[1030]
Bonplandia geminiflora	TGTGAATCTCTTCCCGACCGGGCCAGACCGAATC.GGCCACCACTTGGGATGGGAATGGCTCGGCCC.ACATGCATCATTTTATGAAAGCACTCC..AGC	[1087]
Cantua quercifolia	TGTTCATCTCTTCCCGACCGGGCCAGACCGAATC.GGCCACCACTTGGGATGGGATGGCTCGGCCC.ACATGCATCATTTGATGAAAGCACTCC..AGC	[1052]
Cobaea scandens	TGTGAATCTCTTCCCGACCGGGCCAGACCGAATC.GGCCACCACTTGGGATGGGAATGGCTCGGCCC.ACATGCATCATTTGATGAAAGCACTCC..AGC	[1047]
Acanthogilia gloriosa	TGTGAATCTCTTCCCGACCGGGCCAGACCGAATC.GGCCACCACTTGGGATGGGAATGGCTCGGCCC.ACATGCATCATTTGATGAAAGCACTCCCCAGC	[1058]
Polemonium formosissimum	TGTGAATCTCTTCCCGACCGGGCCAGACCGAATC.GGCCACCACTTGGGATGGGAATGGCTCGGCCC.ACATGCATCATTTGATGAAAGCACTCC..AGC	[1047]
Gilia splendens	....	[846]
Collomia grandiflora	TGTGAATCTCTTCCCGACC................GGCCACCACTTGGGATGGGAATGGCTCGGCCC.ACATGCATCATTTGATGAAAGCACTCC..AG.	[1173]
Allophyllum gilioides	TGTGAATCTCTTCCCGACC................GGCCACCACTTGGGATGGGAATGGCTCGGCCC.ACATGCATCATTTGATGAAAGCACTCC..AG.	[961]
Ipomopsis aggregata	TGTGAATCTCTTCCCGACCGGGCCAGACCGAATC.GGCCACCACTTGGGATGGGAATGGCTCGGCCC.ACATGCATCATTTGATGAAAGCACTCC..AGC	[1066]
Loeselia glandulosa	TGTGAATCTCTTCCCGACCGGGCCAGACCGAATC.GGCCACCACTTGGGATGGGAATGGCTCGGCCC.ACATGCATCATTTGATGAAAGCACTCC..AGC	[1061]
Aliciella micromeria	TGTGAATCTCTTCCCGACCGGGCCAGACCGAATCGGGCCACCACTTGGGATGGGAATGGCTCGGCCC.ACATGCATCATTTGATGAAAGCACTCC..AGC	[1068]
Aliciella subnuda	TGTGAATCTCTTCCCGACCGGGCCAGACCGAATCGGGCCACCACTTGGGATGGGAATGGCTCGGCCC.ACATGCATCATTTGATGAAAGCACTCC..AGC	[1070]
Aliciella mcvickerae	TGTGAATCTCTTCCCGACCGGGCCAGACCGAATCGGGCCACCACTTGGGATGGGAATGGCTCGGCCC.ACATGCATCATTTGATGAAAGCACTCC..AGC	[1067]
Aliciella latifolia	TGTGAATCTCTTCCCGACCGGGCCAGACCGAATCGGGCCACCACTTGGGATGGGAATGGCTCGGCCC.ACATGCATCATTTGATGAAAGCACTCC..AGC	[1066]
Gilia cf. scabra	TGTGAATCTCTTCCCGACCGGGCCAGACCGAATC.GGCCACCACTTGGGATGGGAATGGCTCGGCCC.ACATGCATCATTTGATGAAAGCACTCC..AGC	[1066]
Linanthus nuttallii	TGTGAATCTCTTCCCGACCG...............GGCCACCAGTTGGGCTGGGAATGGTTCGGCCC.ACATGCATCATTTGATGAATGCACTCC..AG.	[949]
Phlox gracilis	TGTGAATCTCTTCCCGACCGGGCCAGACCGAATCGGGCCACCACTTGGGATGGGAATGGCTCGGCCC.ACATGCATCATTTGATGAAAGCACTCC..AGC	[946]
Leptodactylon pungens	TGTGAATCTCTTCCCGACCG...............GGCCACCACTTGGGATGGGAATGGCTCGGCCC.ACATGCATCATTTGATGAAAGCACTCC..AG.	[945]

Appendix 1. Continued.

	1310 1320 1330 1340 1350 1360 1370 1380 1390 1400	
Oenothera berteriana	C.....GCCTCCTCGAAGTGGCTTGTCAACCACGCTTTCCCTCCCTCAAAACAAGGGTCCTCACCGAA....CTTCC.TTGGGTTGGGGCAACACAGCAA	[1142]
Carpenteria californica	CCAGTCGCCTCCTCGAAGTGGTTTGTCAACCACGCTTTCCCTCCCTCAAAACAATGCTCCTCACCAAATGCCCTTCC.TTGGGTTGGGGCAAGACAGCAA	[1017]
Astragalus equisolensis	....	[871]
Viburnum sieboldii	CCAGTCGCCTCCTCGAAGTGGTTTGTCAACC.....TTCCCTCCCTCAAAACAATGCTCCTCACCAAATGCCCTTCC.TTGGGTTGGGGCAACACAGCAA	[1134]
Pholisma arenaria	....	[874]
Petunia hybrida3704b	....	[890]
Hymenoxys richardsonii	....	[719]
Hymenoxys hoopesii	....	[719]
Dodecatheon clevelandii	CCATTCGCCTCCTCGAAGTGGTTTGTCAACCACGCTTTCTCTCCCTCAAAACAATGCTCCTCACCAAATGCCCTTCCCTTGGGTTGGGGCAAGACAGCAA	[1135]
Anagallis arvensis	CCATTCGCCTCCTCGAAGTGGTTTGTCAACCACGTTTTCTCTACCTCAAAACAATGCTCCTCACCAAATGCCCTTCC.TTGGCTTGGGGCAACACAGCAA	[1132]
Ornithostaphylos oppositifolia	CCAG..	[1054]
Styrax redivivus	CCAGTCGCCTCCTCGAAGTGGTTTGTCAACCACGCTTTCCCTCCCTCAAAACAATGCTCCTCACCAAATGCCCTTCC.TTGGGTTGGGGCAACACAGCAA	[1161]
Diapensia lapponica	CCAG..	[1028]
Fouqueria splendens	CCAGTAGCCTCCTCGAAGTGGTTTGTCAACCACGCTTTCCCTCCCTCAAAACAATGGTCCTCACCAAATGCCCTTCC.TTGGGTTGGGGCAAGACAGCAA	[1129]
Bonplandia geminiflora	CCAGTCGCCTCCTCGAAGTGGTTTGTCAACCACGCTTTCCCTCCCTCAAAACAATGCTCCTCACCAAATGTCCTTCC........GGGGCAACACAGCAA	[1179]
Cantua quercifolia	CCAGTC........GAAGTGGTTTGTCAACC..........TCCCTCAAAACAATGCTCCTCACCAAATGTCCTTCC.TTGGGTTGGGGCAACACAGCAA	[1133]
Cobaea scandens	CCAGTCGCCTCCTCGAAGTGGTTTGTCAACC......TCCCTCCCTCAAAACAATGCTCCTCACCAAATGTCCTTCC........GGGGCAACACAGCAA	[1133]
Acanthogilia gloriosa	CCAGTCGCCTCCTCGAAGTGGTTTGTCAACCACGCTTTCCCTCCCTCAAAACAATGCTCCTCACCAAATGTCCTTCC.TTGGGTTGGGGCAACACAGCAA	[1157]
Polemonium formosissimum	CCAGTCGCCTCCTCGAAGTGGTTTGTCAACCACGCTTTCCCTCCCTCAAAACAATGCTCCTCACCAAATGTCCTTCC........GGGGCAACACAGCAA	[1139]
Gilia splendens	....	[846]
Collomia grandiflora	.......CCTCCTCGAAGTGGTTTGTCAACCACGCTTTCCCTCCCTCAAAACAACGCTCCTCACCAAATGTCCTTCC........GGGGCAACACAGCAA	[1258]
Allophyllum gilioides	.......CCTCCTCGAAGTGGTTTGTCAACCACGCTTTCCCTCCCTCAAAACAACGCTCCTCACCAAATGTCCTTCC........GGGGCAACACAGCAA	[1046]
Ipomopsis aggregata	CCAGTCGCCTCCTCGAAGTGGGTTGTCAACCACGCTTTCCCTCCCTCAAAACAATGCTCCTCACCAAATGTCCTTCC........GGGGCAACACAGCAA	[1158]
Loeselia glandulosa	CCAGTCGCCTCCTCGAAGTGGTTTGTCAACCACGCTTTCCCTCCCTCAAAACAATGCTCCTCACCAAATGTCCTTCC........GGGGCAACACAGCAA	[1153]
Aliciella micromeria	CCAGTCGCCTCCTCGAAGTGGTTTGTCAACCACGCTTTCCCTCCCTCAAAACAATGCTCCTCACCAAATGTCCTTCC.TTGGGTTGGGGCAACACAGCAA	[1167]
Aliciella subnuda	CCAGTCGCCTCCTCGAAGTGGTTTGTCAACCACGCTTTCCCTCCCTCAAAACAATGCTCCTCACCAAATGTCCTTCC.TTGGGTTGGGGCAACACAGCAA	[1169]
Aliciella mcvickerae	CCAGTCGCCTCCTCGAAGTGGTTTGTCAACCACGC.......CCCTCAAAACAATGCTCCTCACCAAATGTCCTTCC........GGGGCAACACAGCAA	[1152]
Aliciella latifolia	CCAGTCGCCTCCTCGAAGTGGTTTGTCAACCACGCTTTCCCTCCCTCAAAACAATGCTCCTCACCAAATGTCCTTCC........GGGG.....CAGCAA	[1153]
Gilia cf. scabra	CCAGTCGCCTCCTCGAAGTGGGTTGTCAACCAGGCTTTCCCTCCCTCAAAACAATGCTCCTCACCAAATGTCCTTCC.TTGGGTTGGGGCAACACAGCAA	[1165]
Linanthus nuttallii	......CCCTCCTCGAAGTGGTTTGTGAACCACGCTTTCCCTCCCTCAAAACAACGCTCCTCACCAAATGTCGTTCC........GGGGCAACACAGCAA	[1035]
Phlox gracilis	CCAGTCGCCTCCTCGAAGTGGGTTGTCAACCACGCTTTCCCTCCCTCAAAACAATGCTCCTCACCAAATGTCCTTCC.TTGGGTTGGGGCAACACAGCAA	[1045]
Leptodactylon pungens	.........TCCTCGAAGTGGTTTGTCAACCACGCTTTCCCTCCCTCAAAACAACGCTCCTCACCAAATGTCCTTCC........GGGGCAACACAGCAA	[1028]

Appendix 1. Continued.

	1410 1420 1430 1440 1450 1460 1470 1480 1490 1500	
Oenothera berteriana	TGAGTAGTTCGC.TTCAGGACTCCACCCCCTCGAGAGCAGGATGCCGACCGAGATAGAGCTGGGAGCCAACCTAACCTTTCCTGGGGTTTGCC...CTGC	[1238]
Carpenteria californica	TGAGTAGTTCGC.TCCAGGACCCCACCCCCTCGAGAGCAGGATGCCAGCCGAGATGGAGCTGGGAGCCAACCTATACTTTCCTGGGGCTTGCC...TTGC	[1112]
Astragalus equisolensis	........................ACCCCCTCGAGAGCAGGATGCCGGCCGAGATGGAGCTGGGAGCTTACCTAGACTTTCCTGGGGCTTGCC...TTGC	[944]
Viburnum sieboldii	TGAGTAGTTTCGCTCCAGGACCCCACCCCCTCGAGAGCAGGATGCCGGCCGAGATGGAGCTGGGAGCCAACCTATACTTTCCTGGGGCTTGCC...TTGC	[1231]
Pholisma arenaria	....	[874]
Petunia hybrida3704b	....	[890]
Hymenoxys richardsonii	....	[719]
Hymenoxys hoopesii	....	[719]
Dodecatheon clevelandii	TGAGTAGTTCGC.TCCAGGACCCCACCCTCTCGAGAGCGGGATGCCGGCCGAGATGGAGCTGGGAGCCAACCTAAACTTTCCTGGGGCTTGCCGCCTTGC	[1234]
Anagallis arvensis	TGAGTAGTTCGC.TCCAGGACCCCACCCCCTTGAGAGCGGGATGCCGGCTGAGATGGAGCTGGGAGCCAACCTAAACTTTCCTGGGGCTTGCC...TTGC	[1228]
Ornithostaphylos oppositifolia	....	[1054]
Styrax redivivus	TGAGTAGTTCGT.TCCAGGACCCCACCCCCTCGAGAGCAGGATGCCGGCCGAGATGGAGCTGGAAGCCAACCTATACTTTCCCGGAGCTTGCC...TTGC	[1257]
Diapensia lapponica	....	[1028]
Fouquieria splendens	TGAGTAGTTCGC.TCCAGGACCCCACCCCCTCGAGAGCAGGATGCCGGCCGAGATGGAGCTGGGAGCCAACCTATACTTTCCTGGGGCTTGCC.......	[1221]
Bonplandia geminiflora	TGAGTAGTTAAC.TCCAGGACCCCACCCCCTCGAGAGCAGGATGCCGGCCGAGATGGAGTTGGGAGCCAACCTATACTTTCCTGTGGCTTGCC...TTGC	[1275]
Cantua quercifolia	TGAGTAGTTAAC.TCCAGGACCCCACCCCCTCGAGAGCAGGATGCCGGCCGAGATGGAGTTGGGAGCCAACCTATACTTTCCTGTGGCTTGCC...TTGC	[1229]
Cobaea scandens	TGAGTAGTTAAC.TCCAGGACCCCACCCCCTCGAGAGCAGGATGCCGGCCGAGATGGAGTTGGGAGCCAACCTATACTTTCCTGTGGCTTGCC...TTGC	[1229]
Acanthogilia gloriosa	TGAGTAGTTAAC.TCCAGGACCCCACCCCCTCGAGAGCAGGATGCCGGCCGAGATGGAGTTGGGAGCCAACCTATACTTTCCTGTGGCTTGCC...TTGC	[1253]
Polemonium formosissimum	TGAGTAGTTAAC.TCCAGGACCCCACCCCCTCGAGAGCAGGATGCCGGCCGAGATGGAGTTGGGAGCCAACCTATACTTTCCTGTGGCTTGCC...TTGC	[1235]
Gilia splendens	....	[846]
Collomia grandiflora	TGAGTAGTTAAC.TCCAGGACCCCACCCCCTCGAGAGCAGGATGCCGGCCGAGATGGAGTTGGGAGCCAACCTATACTTTCCTGTGGCTTGCC...TTGC	[1354]
Allophyllum gilioides	TGAGTAGTTAAC.TCCAGGACCCCACCCCCTCGAGAGCAGGATGCCGGCCGAGATGGAGTTGGGAGCCAACCTATACTTTCCTGTGGCTTGCC...TTGC	[1142]
Ipomopsis aggregata	TGAGTAGTTAAC.TCCAGGACCCCACCCCCTCGAGAGCAGGATGCCGGCCGAGATGGAGTTGGGAGCCAACCTATACTTTCTTGTGGCTTGCC...TTGC	[1254]
Loeselia glandulosa	TGAGTAGTTAAC.TCCAGGACCCCACCCCCTCGAGAGCAGGATGCCGGCCGAGATGGAGTTGGGAGCCAACCTATACTTTCTTGTGGCTTGCC...TTGC	[1249]
Aliciella micromeria	TGAGTAGTTAAC.TCCAGGACCCCACCCCCTCGAGAGCAGGATGCCGGCCGAGATGGAGTTGGGAGCCAACCTATACTTTCCTGTGGCTTGCC...TTGC	[1263]
Aliciella subnuda	TGAGTAGTTAAC.TCCAGGACCCCACCCCCTCGAGAGCAGGATGCCGGCCGACATGGAGTTGGGAGCCAACCTATACTTTCCTGTGGCTTGCC...TTGC	[1265]
Aliciella mcvickerae	TGAGTAGTTAAC.TCCAGGACCCCACCCCCTCGAGAGCAGGATGCCGGCCGAGATGGAGTTGGGAGCCAACCTATACTTTCCTGTGGCTTGCC...TTGC	[1248]
Aliciella latifolia	TGAGTAGTTAAC.TCCAGGACCCCACCCCCTCGAGAGCAGGATGCCGGCCGAGATGGAGTTGGGAGCCAACCTATACTTTCCTGTGGCTTGCC...TTGC	[1249]
Gilia cf. scabra	TGAGTAGTTAAC.TCCAGGACCCCACCCCCTCGAGAGCAGGATGCCGGCCGAGATGGAGTTGGGAGCCAACCTATACTTTCCTGTGGCTTGCC...TTGC	[1261]
Linanthus nuttallii	TGAGTAGTTAAC.TCCAGGACCCCACCCCCTCGAGAGCAGGATGCCGGCCGAGATGGAGTTGGGAGCCAACCTATACTTTCCTGTGGCTTGCC...TTGC	[1131]
Phlox gracilis	TGAGTAGTTAAC.TCCAGGACCCCACCCCCTCGAGAGCAGGATGCCGGCCGAGATGGAGTTGGGAGCCAACCTATACTTTCCTGTGGCTTGCC...TTGC	[1141]
Leptodactylon pungens	TGAGTAGTTAAC.TCCAGGACCCCACCCCCTCGAGAGCAGGATGCCGGCCGAGATGGAGTTGGGAGCCAACCTATACTTTCCTGTGGCTTGCC...TTGC	[1124]

Appendix 1. Continued.

	1510 1520 1530 1540 1550 1560 1570 1580 1590 1600	
Oenothera berteriana	CCCAACATC....GAAATAAAAGGCGGGCGCCGAAAAGGAA....CCTGCC...............AG.CCTCTTCAAGAAAGCTTTGCTTGGTAGGCGC	[1314]
Carpenteria californica	CCCAACAT..........AAAGGGCGGGCGCCGAAAAGGAA....CCAGCCC..............AG.CCTCTTCAAGAAAGCTTTGCTTGGTAGGCGC	[1184]
Astragalus equisolensis	CCCTACATC....TAAATCAAAAGCGGGCGCCGAAAAGGAA....CCAGCCC..............AG.CCTCTTCAAGAAAGCTTTGCTTGGTAGGCGC	[1021]
Viburnum sieboldii	CTCAACATCTAAATCAAAAAAGGGTGGGCGCCGAAAAGGAA....CCAGCCC..............AG.CCTCTTCAAGAAAGCTTTGCTTGGTAGGCGC	[1312]
Pholisma arenaria	....	[874]
Petunia hybrida3704b	....	[890]
Hymenoxys richardsonii	....	[719]
Hymenoxys hoopesii	....	[719]
Dodecatheon clevelandii	CCCAACATC....TAAATAAAGGGCGGGCGCCGAAAAGGAA....CCAGCCC..............AG.CCTCTTCAAGAAAGCTTTTCTTGGTAGGCGC	[1311]
Anagallis arvensis	CCCAACATC....TAAATAAAGGGCGGGCGCCGAAAAGGAA....GCAGCCC..............AG.CCGCTTCAAGAAAGCTTTGCTTGGTAGGCGC	[1305]
Ornithostaphylos oppositifolia	....CCTCTTCAAGAAAGCTTTGCTTGGTAGGCGC	[1085]
Styrax redivivus	CCCAACATC....TAAATAAAGGGTGGGCGCCGAAAAGGAA....GCAGCCC..............AG.CCTCTTCAAGAAAGCTTTGCTTGGTAGGCGC	[1334]
Diapensia lapponica	....CCTCTTCAAGAAAGCTTTGCTTGGTAGGCGC	[1059]
Fouqueria splendens	.CCAACATC....TAAATAAAGGGCGGGCGCCGAAAAAGAA....CCAGCCC..............AG.CCTCTTCAAGAAAGCTTTGCTTGGTAGGCGC	[1297]
Bonplandia geminiflora	CCCAACATC....TAAATAAAGGGCGGGCGCCGAAAAAGAAAGAACCAGCCCTTCTCTAATCTAATAGGGCTCTTCAAGAAAGC.......GGTAGGCGC	[1364]
Cantua quercifolia	CCCAACATC....TAAATAAAGGGCGGGCGCCGAAAAAGAAAGAACCAGCCCTTCTCTAATCTAATAGGGCTCTTCAAGAAAGC.......GGTAGGCGC	[1318]
Cobaea scandens	CCCAACATC....TAAATAAAGGGCGGGCGCCGAAAAAGAAAGAACCAGCCCTTCTCTAATCTAATAGGGCTCTTCAAGAAAGC.......GGTAGGCGC	[1318]
Acanthogilia gloriosa	CCCAACATC....TAAATAAAGGGCGGGCGCCGAAAAAGAAAGAACCAGCCCTTCTCTAATCTAATAGGGCTCTTCAAGAAAGC.......GGTAGGCGC	[1342]
Polemonium formosissimum	CCCAACATC....TAAATAAAGGGCGGGCGTCGAAAAAGAAAGAACCAGCCCTTCTCTAATCTAATAGGGCTCTTCAAGAAAGC.......GGTAGGCGC	[1324]
Gilia splendens	............................CGCCGAAAAAGAAAGAACCAGCCCTTCTCTAATCTAATAGGGCTCTTCAAGAAAGC.......GGTAGGCGC	[911]
Collomia grandiflora	CCCAACATC....TAAATAAAGGGCGGGCGCCGAAAAAGAAAGAACCAGCCCTTCTCTAATCTAATAGGGCTCTTCAAGAAAGC.......GGTAGGCGC	[1443]
Allophyllum gilioides	CCCAACATC....TAAATAAAGGGCGGGCGCCGAAAAAGAAAGAACCAGCCCTTCTCTAATCTAATAGGGCTCTTCAAGAAAGC.......GGTAGGCGC	[1231]
Ipomopsis aggregata	CCCAACATC....TAAATAAAGGGCGGGCGCCGAAAAAGAAAGAACCAGCCCTTCTCTAATCTAATAGGGCTCTTCAAGAAAGC.......GGTAGGCGC	[1343]
Loeselia glandulosa	CCCAACATC....TAAATAAAGGGCGGGCGCCGAAAAAGAAAGAACCAGCCCTTCTCTAATCTAATAGGGCTCTTCAAGAAAGC.......GGTAGGCGC	[1338]
Aliciella micromeria	CCCAACATC....TAAATAAAGGTCGGGCGCCGAAAAAGAAAGAACCAGCCCTTCTCTAATCTAATAGGGCTCTTCAAGAAAGC.......GGTAGGCGC	[1352]
Aliciella subnuda	CCCAACATC....TAAATAAAGGGCGGGCGCCGAAAAAGAAAGAACCAGCCCTTCTCTAATCTAATAGGGCTCTTCAAGAAAGC.......GGTAGGCGC	[1354]
Aliciella mcvickerae	CCCAACATC....TAAATAAAGGGCGGGCGCCGAAAAAGAAAGAACCAGCCCTTCTCTAATCTAATAGGGCTCTTCAAGAAAGC.......GGTAGGCGC	[1337]
Aliciella latifolia	CCCAACATC....TAAATAAAGGGCGGGCGCCGAAAAAGAAAGAACCAGCCCTTCTCTAATCTAATAGGGCTCTTCAAGAAAGC.......GGTAGGCGC	[1338]
Gilia cf. scabra	CCCAACATC....TAAATAAAGGGCGGGCGCCGAAAAAGAAAGAACCAGCCCTTCTCTAATCTAATAGGGCTCTTCAAGAAAGC.......GGTAGGCGC	[1350]
Linanthus nuttallii	CCCAACATC....TAAATAAAGGGCGGGCGCCGAAAAAGAAAGAACCAGCCCTTCTCTAATCTAATAGGGCTCTTCAAGAAAGC.......GGTAGGCGC	[1220]
Phlox gracilis	CCCAACATC....TAAATAAAGGGCGGGCGCCGAAAAAGAAAGAACCAGCCCTTCTCTAATCTAATAGGGCTCTTCAAGAAAGC.......GGTAGGCGC	[1230]
Leptodactylon pungens	CCCAACATC....TAAATAAAGGGCGGGCGCCGAAAAAGAAAGAACCAGCCCTTCTCTAATCTAATAGGGCTCTTCAAGAAAGC.......GGTAGGCGC	[1213]

Appendix 1. Continued.

	1610 1620 1630 1640 1650 1660 1670 1680 1690 1700	
Oenothera berteriana	TGCCTACTCACTCGGACAATGCTCTGAACACGAAAGTGTGCAGTTCCGCCCCC..TTCTCCCA....TGCTGAGTCACAGGCAGCGCCTCGGAAAGCACG	[1408]
Carpenteria californica	TGCCTACTCACTCGGACAATGCTCTGAACACGAAAGTGTGCAGTTCCGCCCCC..TTCTCCCA....TGCTGAGTCACAGGCAGCGCCTCGGAAAGCACG	[1278]
Astragalus equisolensis	TGCCTATTCACTCGGACAATGCTCTAAACACGAAAGTGTG.ACGCCCTCTTTC..TTCTCCCACCCATGCTGAGTCACAGGCAGCGCCTCGGAAAGCGCG	[1118]
Viburnum sieboldii	TGCCTACTCACTCGGACGATGCTCTGAACACGAAAGTGTGCAGTTCCGCCCCC..TTCTCCCA....TGCTGAGTCACAGGCAGCGCCTCGGAAAGCACG	[1406]
Pholisma arenaria	....TTTCTCCCA....TGCTGAGTCACAGGCAGCGCCTCGGAAAGCACG	[916]
Petunia hybrida3704b	....TTCTCCCA....TGCTGAGTCACAGGCAGCGCCTCGGAAAGCACG	[931]
Hymenoxys richardsonii	....AAAAGCACG	[728]
Hymenoxys hoopesii	....AAAAGCACG	[728]
Dodecatheon clevelandii	TGCCTGCTCACTCGGACAATGCTCTGAACACGAAAGTGTTAAATTCCGCCCCC..TTCTCCCA...TTGCTGAGTCACAGGCAGCGCCTCGGAAAGCACG	[1406]
Anagallis arvensis	TGCCTGCTCACTCGGACAATGCTCTGAACACGAAAGTGTGCAATTCCGCCCCC..TT.CCCCA...TTGCTGAGTCACAGGAAGCGCCTCGGAAAGCACG	[1399]
Ornithostaphylos oppositifolia	TGCCTACTCACTCGGACAATGCTCTGAACACGAAAGT.......TCCGCCCCC..TTCTCCCA....TGCTGAGTCACAGGCAGCGCCTCGGAAAGCACG	[1172]
Styrax redivivus	TGCCTACTCACTCGGACAATGCTCTGAACACGAAAGTGTGCAGTTCCGCCCCC..TTCTCCCA....TGCTGAGTCACAGGCAGCGCCTCGGAAAGCACG	[1428]
Diapensia lapponica	TGCCTACTCACTCGGACAATGCTCTGAACACGAAAGTGTGCAGTTCCGCCCCC..TTTTCCCA....TGCTGAGGCACAGGCAGCGCCTCGGAAAGCACG	[1153]
Fouqueria splendens	TGCCTACTCACTCGGACAATGCTCTGAACACGAAAGTGTGCAGTTCCGCCCCC..TTCTACCA....TGCTGAGTCACAGGCAGCGCCTCGGAAAGCACG	[1391]
Bonplandia geminiflora	TGCCTACTCACTCGGACAATGCTCTGAACACGAAAGTGTGCAGTTCCGCCCCCTTTTCTCCCA....TGCTGAGTCACAGGCAGCGCCTCGGAAAGCACG	[1460]
Cantua quercifolia	TGCCTACTCACTCGGACAATGCTCTGAACACGAAAGTGTGCAGTTCCGCCCCCTTTTCTCCCA....TGCTGAGTCACAGGCTGCGCCTCGGAAAGCACG	[1414]
Cobaea scandens	TGCCTACTCACTCGGACAATGCTCTGAACACGAAAGTGTGCAGTTCCGCCCCCTTTTATCCCA....TGCTGAGTCACAGGCAGCGCCTCGGAAAGCACG	[1414]
Acanthogilia gloriosa	TGCCTACTCACTCGGACAATGCTCTGAACACGAAAGTGTGCAGTTCCGCCCCCTTTTCTCCCA....TGCTGAGTCACAGGCAGCGCCTCGGAAAGCACG	[1438]
Polemonium formosissimum	TGCCTACTCACTCAGACAATGCTCTGAACACGAAAGTGTGCAGTTCCGCCCCCTTTTCTCCCA....TGCTGAGTCACAGGCAGCGCCTCGGAAAGCACG	[1420]
Gilia splendens	TGCCTACTCACTCGGACAATGCTCTGAACACGAAAGTGTGCAGTTCCGCCCCCTTTTCTCCCA....TGCTGAGTCACAGGCAGCGCCTCGGAAAGCACG	[1007]
Collomia grandiflora	TGCCTACTCACCCGGACAATGCTCTGAACACGAAAGTGTGCAGTTCCGCCCCCTTTTCTCCCA....TGCTGAGTCACAGGCAGCGCCTCGGAAAGCACG	[1539]
Allophyllum gilioides	TGCCTACTCACCCGGACAATGCTCTGAACACGAAAGTGTGCAGTTCCGCCCCCTTTTATCCCA....TGCTGAGTCACAGGCAGCGCCTCGGAAAGCACG	[1327]
Ipomopsis aggregata	TGCCTACTCACTCGGACAATGCTCTGAACACGAAAGTGTGCAGTTCCGCCCCCTTTTCTCCCA....TGCTGAGTCACAGGCAGCGCCTCGGAAAGCACG	[1439]
Loeselia glandulosa	TGCCTACTCACTCGGACAATGCTCTGAACACGAAAGTGTGCAGTTCCGCCCCCTTTTCTCCCA....TGCTGAGTCACAGGCAGCGCCTCGGAAAGCACG	[1434]
Aliciella micromeria	TGCCTACTCACTCGGACAATGCTCTGAACACGAAAGTGTGCAGTTCCGCCCCCCTTTCTCCCA....TGCTGAGTCACAGGCAGCACCTCGGAAAGCACG	[1448]
Aliciella subnuda	TGCCTACTCACTCGGACAATGCTCTGAACACGAAAGTGTGCAGTTCCGCCCCCCTTTCTCCCA....TGCTGAGTCACAGGCAGCACCTCGGAAAGCACG	[1450]
Aliciella mcvickerae	TGCCTACTCACTCGGACAATGCTCTGAACACGAAAGTGTGCAGTTCCGCCCCCCTTTCTCCCA....TGCTGAGTCACAGGCAGCACCTCGGAAAGCACG	[1433]
Aliciella latifolia	TGCCTACTCACTCGGACAATGCTCTGAACACGAAAGTGTGCAGTTCCGCCCCCTTTTCTCCCA....TGCTGAGTCACAGG.....CCTCGGAAAGCACG	[1429]
Gilia cf. scabra	TGCCTACTCACTCGGACAATGCTCTGAACACGAAAGTGTGCAGTTCCGCCCCCTTTTCTCCCA....TGCTGAGTCACAGGCAGCGCCTCGGAAAGCACG	[1446]
Linanthus nuttallii	TGCCTACTCACTCGGACAATGCTTTGAACACGAAAGTGTGCAGTTCCGCCCCCTTTTCTCCCA....TGCTGAGTCACAGGCAGCGCCTCGGAAAGCACG	[1316]
Phlox gracilis	TACCTACTCACTCGGACAATGCTCTGAACACGAAAGTGTGCAGTTCCGCCCCCTTTTCTCCCA....TGCTGAGTCACAGGCAGCGCCTCGGAAAGCACG	[1326]
Leptodactylon pungens	TGCCTACTCACCCGGACAATGCTCTGAACACGAAAGTGTGCAGTTCCGCCCCCTTTTCTCCCA....TGCTGAGTCACAGGCAGCGCCTCGGAAAGCACG	[1309]

Appendix 1. Continued.

	1710 1720 1730 1740 1750	
Oenothera berteriana	GACGAGCCACATGCAGGGAAACTTGCACGTGTGGTTCTGGCCGGAGACCCCGGTAT	[1464]
Carpenteria californica	GACGAGCCACATGCAGGGAAACTTGCACGTGTGGTTCTGGCCGGGGACCCCGGTAT	[1334]
Astragalus equisolensis	GGCGAGCCACATGCAGGGAAACTTGCACGTGTGGTTCTGGCCGGGGACCCCGGTAT	[1174]
Viburnum sieboldii	GACGAGCCACATGCAGGGAAACTTGCACGTGTGGTTCTGGCCGGGGACCCCGGTAT	[1462]
Pholisma arenaria	GACGAGCCACATGCAGGGAAACTTGCACGTGTGGTTCTGGCCGGGGACCCCGGTAT	[972]
Petunia hybrida3704b	GACGAGCCACATGCAGGGAAACTTGCACGTGTGGTTCTGGCCGGGGACCCCGGTAT	[987]
Hymenoxys richardsonii	GACGAGCCACATGCAGGGAAACTTGCACGTGTGGTTCTGGCCGGGGACCCCGGTAT	[784]
Hymenoxys hoopesii	GACGAGCCACATGCAGGGAAACTTGCACGTGTGGTTCTGGCCGGGGACCCCGGTAT	[784]
Dodecatheon clevelandii	GACGAGCCACATGCAGGGAAACTTGCACGTGTGGTTCTGGCCGGAGACCCCGGTAT	[1462]
Anagallis arvensis	GACGAGCCACATGCAGGGAAACTTGCACGTGTGGTTCTGGCCGGGGACCCCGGTAT	[1455]
Ornithostaphylos oppositifolia	GACGAGCCACATGCAGGGAAACTTGCACGTGTGGTTCTGGCCGGGGACCCCGGTAT	[1228]
Styrax redivivus	GACGAGCCACATGCAGGGAAACTTGCACGTGTGGTTCTGGCCGGGGACCCCGGTAT	[1484]
Diapensia lapponica	GACGAGCCATATGCAGGGAAACTTGCACGTGTGGTTCTGGCCGGGGACCCCGGTAT	[1209]
Fouqueria splendens	GACGAGCCACATGCAGGGAAACTTGCACGTGTGGTTCTGGCCGGGGACCCCGGTAT	[1447]
Bonplandia geminiflora	GACGAGCCACATGCAGGGAAACTTGCACGTGTGGTTCTGGCCGGGGACCCCGGTAT	[1516]
Cantua quercifolia	GACGAGCCACATGCAGGGAAACTTGCACGTGTGGTTCTGGCCGGGGACCCCGGTAT	[1470]
Cobaea scandens	GACGAGCCACATGCAGGGAAACTTGCACGTGTGGTTCTGGCCGGGGACCCCGGTAT	[1470]
Acanthogilia gloriosa	GACGAGCCACATGCAGGGAAACTTGCACGTGTGGTTCTGGCCGGGGACCCCGGTAT	[1494]
Polemonium formosissimum	GACGAGCCACATGCAGGGAAACTTGCACGTGTGGTTCTGGCCGGGGACCCCGGTAT	[1476]
Gilia splendens	GACGAGCCACATGCAGGGAAACTTGCACGTGTGGTTCTGGCCGGGGACCCCGGTAT	[1063]
Collomia grandiflora	GACGAGCCACATGCAGGGAAACTTGCACGTGTGGTTCTGGCCGGGGACCCCGGTAT	[1595]
Allophyllum gilioides	GACGAGCCACATGCAGGGAAACTTGCACGTGTGGTTCTGGCCGGGGACCCCGGTAT	[1383]
Ipomopsis aggregata	GACGAGCCACATGCAGGGAAACTTGCACGTGTGGTTCTGGCCGGGGACCCCGGTAT	[1495]
Loeselia glandulosa	GACGAGCCACATGCAGGGAAACTTGCACGTGTGGTTCTGGCCGGGGACCCCGGTAT	[1490]
Aliciella micromeria	GACGAGCCACATGCAGGGAAACTTGCACGTGTGGTTCTGGCCGGGGACCCCGGTAT	[1504]
Aliciella subnuda	GACGAGCCACATGCAGGGAAACTTGCACGTGTGGTTCTGGCCGGGGACCCCGGTAT	[1506]
Aliciella mcvickerae	GACGAGCCACATGCAGGGAAACTTGCACGTGTGGTTCTGGCCGGGGACCCCGGTAT	[1489]
Aliciella latifolia	GACGAGCCACATGCAGGGAAACTTGCACGTGTGGTTCTGGCCGGGGACCCCGGTAT	[1485]
Gilia cf. scabra	GACGAGCCACATGCAGGGAAACTTGCACGTGTGGTTCTGGCCGGGGACCCCGGTAT	[1502]
Linanthus nuttallii	GACGAGCCACATGCAGGGAAACTTGCACGTGTGGTTCTGGCCGGGGACCCCGGTAT	[1372]
Phlox gracilis	GACGAGCCACATGCAGGGAAACTTGCACGTGTGGTTCTGGCCGGGGACCCCGGTAT	[1282]
Leptodactylon pungens	GACGAGCCACATGCAGGGAAACTTGCACGTGTGGTTCTGGCCGGGGACCCCGGTAT	[1365]